COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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MOISTURE IN COMPRESSED AIR

BY FRANK RICHARDS.

Users of compressed air are still constantly inquiring about the way to keep the water out of compressed air, and how to prevent the freezing up of the exhaust passages of air-operated machines. This water and freezing-up trouble began with the earliest using of compressed air, and always must be encountered if the proper arrangements are not made to avoid it. Those of long experience with compressed air have generally learned, more or less completely, what it is necessary to do in the case, but as a second or a third generation of air users is now getting into the business, it seems to be necessary to rehearse the matter again, with occasional repetitions in the future.

THERE IS NO DRY FREE AIR.

In the first place, practically nothing can be done until the air has been compressed. Carrying water is one of the principal functions of the air, and we never catch it that it does not carry more or less water vapor mixed with it. The daily reports of the weather show that humidity is the most variable of the atmospheric conditions, much more so than the temperature or the barometric pressure. But there is a lower limit of atmospheric humidity, far above the zero mark, which is never reached and seldom closely approached. When the humidity reaches 100 per cent. that becomes the "dew point," for the conditions then prevailing; the air can carry no more moisture in the form of vapor, the excess being immediately condensed into water, at first only minute globules, but still actual water.

Until the dew point is reached the air is perfectly transparent, and to the touch it is dry air; but when in the upward direction the dew point is passed, the condensed vapor is seen as mist, fog or cloud in the air, more or less dense according to the amount of water liberated, and the air in this condition will wet, or at least dampen, whatever it may happen to touch.

The reason that the atmospheric humidity reports are so constantly varying is that the moisture-carrying capacity of the air is so dependent upon two constantly varying conditions: pressure and temperature, the latter especially. So far as the pressure alone is concerned, the vapor-carrying capacity of the air is almost directly as the volume, or inversely as the absolute pressure. Thus, if air is taken into a compressor at atmospheric pressure, say 15 lb. absolute, and at 50 per cent. humidity (though it is apt to be above that) then if the air is compressed to 15 lb. gage, or two atmospheres, its humidity becomes 100 per cent., and the air can carry no more water as vapor. If the same air is compressed to 45 lb. gage, 60 lb. absolute, or four atmospheres, then one-half of the vapor is condensed into water, and so on for other pressures. If the air we started with at 50 per cent. humidity was compressed to 105 lb. gage, 120 lb. absolute, or eight atmospheres, then only one-quarter of the original moisture could remain in the air as vapor, and three-quarters of it would be condensed into water. These figures will be referred to later.

We have gone along here, as theorizers are apt to do, considering only the one condition of pressure, or corresponding volume, and entirely ignoring the temperature. We could, of course, only have realized the results above predicted if the temperature had remained constant all through, which certainly would not have been the case.

If, now, we consider the temperature alone of the air under compression, we come to results quite different, and, we may say,

quite astonishing. The capacity of air for vapor of water rises rapidly with increase of temperature. The following gives approximately the weight (lb.) of aqueous vapor per pound of atmospheric air at 50 per cent. of saturation and at various temperatures:

Temp. Fahr.	Weight of Vapor per Lb. of Air.	Temp. Fahr.	Weight of Vapor per Lb. of Air.
60	0.00547	140	0.07575
80	0.01099	160	0.14776
100	0.02127	180	0.32471
120	0.04020	200	1.13400

From these figures it will be seen that it requires a rise of only a little over 20 deg. F. to double the vapor-carrying capacity of air. From 60 deg. to 200 there would be seven of these doublings, or the vapor-carrying capacity of the air would have increased from 1 to 128. The actual increase shown is $1.1340 \div 0.00547 = 207$, but this excess is accounted for by the much more rapid rise in the last interval between 180 and 200 deg.

It is to be remembered that the above figures apply to given weights, or actual quantities of air, and not to volumes. In compressing to eight atmospheres the vapor-carrying capacity, so far as volume is concerned, is only one-eighth of what it was before the compression, but with seven doublings of vapor-carrying capacity in consequence of the rise in temperature, the air still has $128 \div 8 = 16$ times the vapor-carrying capacity which it had before the compression began.

The case is more complicated than here outlined, because in adiabatic compression the volume during and at the completion of the compression is not reduced in proportion to the actual pressure increase; but, on the other hand, the temperatures are much higher than we have assumed, and it is evident that at the time of discharge the air must be really in a thirsty condition, although there has been no actual diminution of its vapor content.

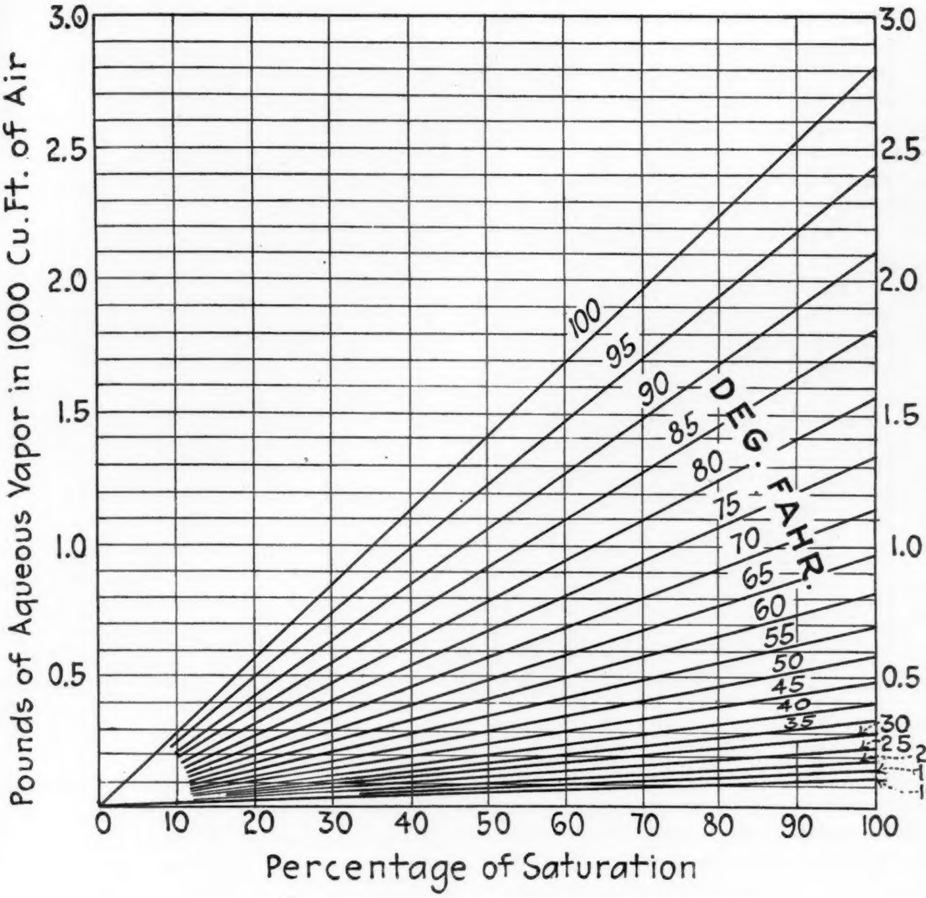
In connection with the preceding the diagram on the opposite page will be found serviceable. It shows the weights of aqueous vapor, in pounds per 1000 cu.ft. of free air, for practically the entire ordinary range of atmospheric temperatures and for different percentages of saturation, the latter being read horizontally at the bottom and the weights of water vertically at the side of the diagram. Each oblique line, or "curve," is figured for the temperature which it represents. The greater spacing for the higher temperatures, showing the increased water capacity, is quite striking. At 100 per cent. saturation, as also for any other percentage, the difference in the moisture content between 100 and 95 deg. F. is just equal to the difference between 45 and 10 deg., the latter difference being seven times as many degrees as the former. By extending the scale of temperatures upward, the differences would, of course, show much larger.

When free air is taken into a compressor at a normal temperature of, say, 60 deg., and is compressed to 105 lb. gage, the theoretical temperature is close to 500 deg., which temperature is much lowered if the compression be in two stages with efficient intercooling. If there is no aftercooler, it is doing well if the air is delivered at a temperature not above 200 deg.

The air now is no condition to give up any of its moisture, and with the air receiver located near the compressor, the air is only slightly cooled, if at all, in passing through the receiver. There are those who continue to expect otherwise, but they are continually disappointed.

THE COOLING OF THE AIR.

If, however, the air after leaving the receiver is transmitted through suitable pipes to a considerable distance, as it usually is, it is almost certain to be cooled to about normal temperature. The specific heat of air is low, so that when its temperature is high to the senses or to the thermometer it represents little in actual heat units, and has little heat to surrender to its surroundings, even when cooling rapidly. With the air thus cooled in the pipes, both the conditions of high pressure and of low temperature will be the best possible for the condensation and release of the greatest possible amount of water vapor. With the temperature of the air the same as it was before the compression began, the temperature will no longer have any effect in increasing the vapor-carrying capacity, and with the volume of the air reduced to one-eighth of what it was at the beginning, its vapor capacity will be only one-eighth of what it was. If the air when taken in is at the point of saturation, or 100 per cent. humidity, then if the air is compressed to one-eighth the volume, seven-eighths of the vapor can no longer be carried



as vapor. If the air was taken in at 50 per cent. of saturation, then only one-quarter of the original vapor can be carried as such, and three-quarters of the vapor will be condensed, and so on for other pressures.

DRAINING OFF CONDENSED VAPOR.

When the saturation point is reached and passed, in consequence of a change in the combination of volume and temperature, the one being increased or the other reduced, then the air at once unerringly gives up all the surplus of vapor beyond what it can carry. That is, the vapor is condensed into liquid globules, but unless something more is done about it, the moisture will still remain in the air, though in the liquid instead of the gaseous state. At the point of saturation, if the pressure were diminished or the temperature increased, some of the liquid would be vaporized again and become an intimate part of the air as before. If the conditions were reversed. the pressure being increased or the temperature reduced, more of the vapor would be condensed and the proportion of vapor remaining as part of the air would be reduced. On a summer day one may watch the clouds forming or gradually disappearing before his eyes as minute changes of pressure or of temperature occur.

The water condensed from vapor in the air, but still remaining in it in the liquefied condition, seems to be ready enough to get out of the air if given the opportunity. If compressed air just delivered from a compressor with an aftercooler, and thus overloaded with condensed moisture, could be kept in a mass in a quiescent state, the water would slowly go to the bottom of the containing vessel; but it has no time to stop when passing through an ordinary receiver. If the air is in motion

the liberated moisture it contains will wet and cling to whatever the air touches.

If the air in this super-saturated condition, due to high pressure and low temperature, is passed through a steam separator, of any of the types of proved efficiency, the entrained water will be taken out of the air just as it is taken out of wet steam. As wet air flows along in a pipe line, the inner surface of the pipe will be wet, the water will trickle down the sides and flow along in a stream at the bottom. If there are low places in the line, and if pockets or settling chambers are provided at these points, the water will accumulate there and can be drawn off at intervals. If the water is not thus drawn off, it must be carried along bodily by the air at last into the drills, pneumatic hammers or other tools, and the neglect to drain off the water before the air comes to the point where it is to be used is the cause of most of the trouble of which complaint is made.

It is a natural and proper inference from the preceding that the higher the transmission pressure of the air, the greater will be the opportunity of draining it of moisture, and if the opportunity is taken advantage of, the less will be the possibility of trouble in the subsequent use of the air. With a system calling for comparatively low-pressure air, with single-stage compression and without aftercooler or separator or any provision for taking the water out of the pipes, the water will not allow itself to be ignored when it comes to the exhaust passages.

REHEATING COMPRESSED AIR.

Nothing probably needs to be said of the theoretical economy and advantage of reheating compressed air before putting it to use. By reheating, the working volume of the air may be quite materially increased at slight cost and the freezing-up trouble may be annihilated. It must be remembered, however, that practically little reheating has been or is being done. For driving tools or machines which are only operated intermittently, and which have no fixed position, reheating of the air is not practicable and costs more than it is worth, but for the driving of pumps or for any other constant employment, the air should always be reheated as closely as possible to the work.—*Power.*

JACKHAMERS IN SHAFT SINKING

An interesting job of shaft sinking for the Dakota Continental Copper Company is now in progress at Hill City, S. D. For the information following concerning it we are indebted to Mr. W. J. Booth, Manager.

The shaft measures 7 by 18 feet before the timbering is put in. It is timbered into three compartments; two for hoisting and the third a pipe and man-way. The shaft is very wet, so that water is pumped at the rate of 200 gallons per minute, night and day.

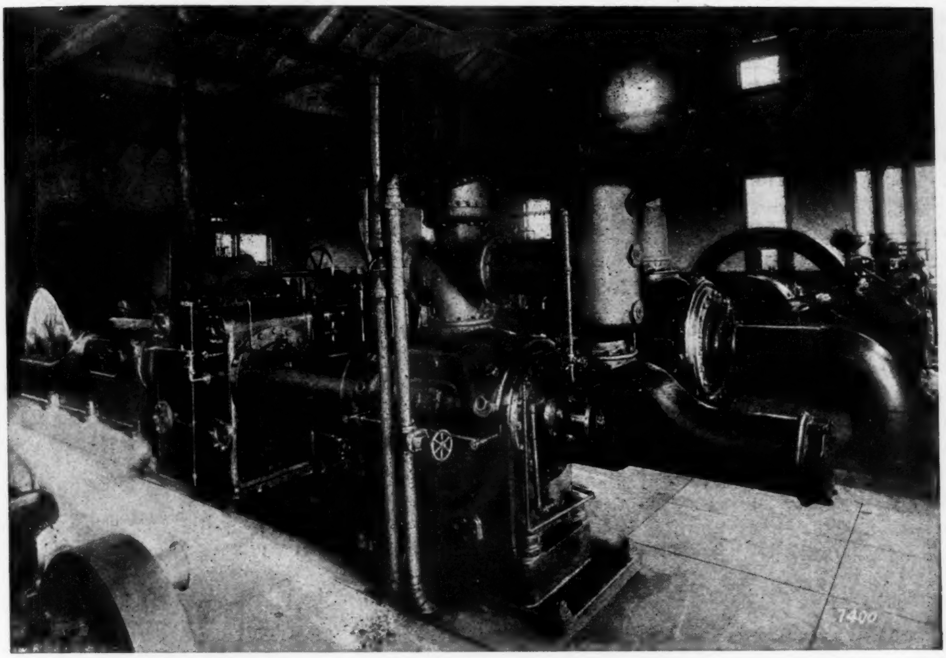
Three eight hour shifts are run, with four men in the bottom of the shaft at a time, each of these operating a Jackhamer drill when not mucking out. The muck is lifted from the bottom in 1800 lb. buckets by a double reel steam hoisting engine capable of lifting 6 tons 1200 ft. per minute.

We have, our account continues, no way of comparing the Jackhamer with hand work, but we had considerable experience with piston drills on the job. The conditions now are practically the same as with the piston drills but we have found that using the Jackhamer we are able to sink just twice as fast. We are averaging 1¼ ft. per day, this including timbering and piping.

Our rock is extremely hard, with stringers of almost pure iron running through which will give any machine plenty of grief, but we have demonstrated that even under adverse circumstances the Jackhamers, with the same number of men, do faster work than the piston drills.

Our greatest difficulty we found in drilling the out-holes, which nearly always had to be started under water, and this allowed loose rock and drillings to wash into the hole and clog the drill. We obviated this by putting a piece of 2½ in. pipe about 1 ft. long into the collar of the hole and wrapping a gunny sack around it; then by using a blow-pipe frequently we were able to put down 6 ft. holes without very much trouble.

We are running with a compressor 20 and 20 and 20x24. We are not able to state just the amount of air the four Jackhamers are using because the same compressor is furnishing air for a No. 9-B Cameron Sinker. The four Jackhamers take less air than the two piston drills, because it takes two cords of wood less to run the compressor.



COMPRESSOR AT NO. 5 COLLIERY, LEHIGH AND WILKESBARRE COAL CO.

SOME EFFICIENT AIR COMPRESSING PLANTS AT COAL MINES

BY S. W. SYMONS.

Economy in the operation of machinery, like the cost of living, is rather more a question of ratios than one of absolute values. The cycle of operations in the compressed-air mining installation is so long and complex from the combustion of the fuel in the boiler furnace to the coal cutting or pumping at the working face, that from the thermodynamic standpoint no figures of high efficiency can possibly be secured.

In spite of the many losses which the ingenuity of man has never succeeded in stopping, there are numerous others which are capable of elimination either in total or in part. That installation, then, which cuts down these needless wastes to a minimum may, by comparison with other plants erected for the same purpose, be justly and rightly termed economical. It is the purpose of this article to describe four plants coming under this category which are in successful daily operation in the anthracite-coal region of Pennsylvania.

At the No. 5 colliery of the Lehigh & Wilkes-Barre Coal Co., at South Wilkes-Barre, Penn., air has been supplied for the last 8 years by an Ingersoll-Sergeant duplex compressor. This machine is provided with simple Meyer valve steam cylinders and two-stage air cylinders compressing to 100 lb. It has been kept running 24 hours a day since installation, and is now being rebuilt preparatory to being put again into regular service.

A new compressor, shown above, which was installed a year ago, was built by the Ingersoll-Rand Co. It is of the duplex type with Corliss steam cylinders 28 and 42 in. in diameter, hurricane inlet air cylinders 37¼ and 22¼ in. in diameter, respectively, while the common stroke is 36 in. The capacity at 100 r.p.m. is 4,206 cu. ft. of free air per minute compressed to 100 lb.

The steam cylinders are fitted with a type of Corliss valve-gear, claimed by the makers to be highly efficient and nearly silent. This latter claim is well borne out by the smooth, quiet running of the machine, the only noticeable sound being the slight clicking of the relief gear and the sucking of the dash pot. The

crank end of this machine, being wholly inclosed, provides a reservoir for a continuous oiling system for all the bearings except the valve-gear.

Hurricane piston inlet valves are used on both air cylinders, the intake air coming through a conduit under the engine room floor to the hollow piston rod of the low pressure cylinder. The discharge valves are of the simple poppet type.

The air upon leaving the low-pressure cylinder passes through an intercooler of the usual surface condenser construction, from whence it passes through a trap in which the moisture which has condensed in the intercooler, is caught on baffles and drained into a small tank placed on the foundation. The amount of moisture drained from the air by this device will depend on the percentage of saturation of the air before entering the compressor and the temperature at which it leaves the intercooler.

It has been demonstrated that the capacity of air to absorb moisture increases directly with the volume, regardless of pressure, and that it practically doubles with every 20 deg. F. increase in temperature.

To take for illustration an actual case, in order to show the efficiency of the device, a two-stage compressor designed for 90-lb. terminal pressure at sea level will carry about 27 lb. gage, or nearly three atmospheres absolute in the inter-cooler. This will give a temperature of about 240 deg. F. on leaving the low-pressure cylinder, if the intake temperature were 60 deg.

Assuming that the air on entering the compressor is in a saturated condition, the fact that its volume has been reduced by compression to nearly one-third would mean that nearly two-thirds of this moisture would be precipitated, provided the temperature was reduced in the intercooler to 60 deg.

This is wherein lies the usefulness of the intercooler. But although this amount of moisture is given up by the air, it is not precipitated, but the greater part hangs in the air in the form of a mist, and in the average installation is carried over into the high-pressure cylinder, where it is again taken up by the air, owing to the heat of compression, thus causing a loss of power, besides trouble in the pipe line and at the points where the air is used. With the form of trap just described, nearly all of this moisture is caught and drained off.

Of course, the ideal conditions would be to extract all of this moisture before the air enters the compressor. This, however, would be impossible without a refrigerating plant. Much can be done, however, by taking the air from the coolest point possible, not from the inside of the engine room, or by installing some form of pre-cooler, which might be so designed as to clean the air as well as lower its temperature.

A UNIQUE AIR CLEANER.

A unique form of air cleaner is placed on the inlet to this machine. This is constructed of concrete and consists of a pit or box a little below the level of the engine room. A cover is placed over this box provided with openings so screened as to exclude large particles of foreign matter. The bottom of this chamber is filled with a heavy oil, just above the surface of which is placed a horizontal pipe provided with a long slot on the under side with one end closed and the other connected with the compressor intake conduit.

The air in passing to the compressor suction impinges more or less on the oil in the basin, leaving behind much dust and grit which would otherwise be carried over into the machine to the detriment of the valves and pistons. The oil can be easily removed and renewed as found necessary.

The use of this cleaner is of great benefit to the proper working of the compressor, and credit is due to the Lehigh & Wilkes-Barre Co. therefor, the device having been constructed by their engineers. It is, of course, impossible to put down in figures the saving realized by such an apparatus, its operation being in the nature of a preventive rather than a cure. Some such cleaning device should, however, form a part of every up-to-date compressor installation.

The air from this machine is used to operate underground hoisting engines during the day, and at night a single pump for unwatering the mine, which takes the full capacity of the compressor, is operated.

LITTLE STEAM USED.

The engineer in charge made the assertion that his compressor used little if any more steam than the older machine of about one-half its capacity; and this in spite of the fact that the steam pressure fluctuates anywhere between 80 and 100 lb., so that the engine at times runs practically without cutoff.

A compressor of the same type but slightly smaller, was installed two years ago at the plant of the Kingston Coal Co., at Kingston, Penn., to take the place of two straight-line tandem-compound compressors with a combined capacity of 5,000 cu. ft., which were installed some years before.

The new machine has a rated capacity of 3,336 cu. ft. at 120 r.p.m., compressing to 100 lb. It easily takes care of this load, but owing to the increased use of air in the mine, another compressor of the same type and design is to be installed.

A BATTERY OF RECEIVERS.

The air is piped to a battery of receivers, consisting of three 42-in. by 34-ft. cylindrical tanks coupled together. It is led in at the top to a pipe connection in the center of the battery. Provision is made for the new compressor when installed at the other end of the system.

This air-storage system was installed by the coal company to take care of the fluctuations of the load, and worked out well in practice. The air is used for pumps and hoisting engines underground.

This compressor is installed beneath a coal breaker, and consequently under unfavorable conditions, the intake being only protected by wire screens. In spite of this fact, however, it has not been necessary to renew any of the air-inlet valves or valve springs since installation. The machine runs 24 hours per day, and has been speeded up to 125 r.p.m. for hours at a time.

At the Gaylord mine of the Kingston Coal Co., at Plymouth, Penn., another machine of the same type is installed chiefly for operating the mine hoist. This compressor has a capacity of 2000 cu. ft. at 134 r.p.m., and runs so smoothly that the writer was able to balance a nickel on edge on top of the main frame, while the machine was operating at 125 r.p.m. This compressor takes the place of an old Ingersoll-Seargent straight-line machine.

At the Plymouth Coal Co.'s Dodson mine, also in Plymouth, Penn., a compressor of the same size and type as that installed at the Kingston plant was put in to take the place of a 10-year-old duplex machine, a relic of former days. This compressor has run constantly for the last year and a half, generally being speeded up to about 125 r.p.m., or 750 ft. piston speed.

This compressor, about a year ago, was put to a rather unusual use. Fire had broken out in the workings, and it was found to be impossible to get any fire-fighting apparatus within reach of the flames, owing to the noxious gases present. This difficulty was overcome by directing the full capacity of the compressing plant, which includes a small straight-line machine, besides that above mentioned, into the workings and forcing the gases back until the fire-fighters were enabled to get near enough to extinguish the fire.

In all of the above mentioned plants, the steam pressure fluctuates considerably. This does not, however, appear to interfere with the proper operation of the Corliss compressors, but makes it impossible to obtain any actual record of economy.—*Coal Age.*

HAMMER DRILLS ON HIGHWAY WORK

The construction of road 5266 of the New York State highway system in Jefferson County requires the excavation of about 5000 cu. yd. of rock in what is known locally as the Depauville cut. At this point the road, which is of water-bound macadam, passes over Graber Hill, the grade formerly being 10 to 12 per cent., but by making a cut of more than 25 ft. at its maximum depth the grade was reduced to approximately 4 per cent. The soil of Graber Hill is underlaid at a depth of about 2 ft. with a 7-ft. stratum of gray limestone. The limestone is unusually hard and tough and is interlaid at intervals of approximately 1 ft. with seams of hard clay from ½ to 3 in, in thickness. The removal of the limestone by ordinary methods was found to be exceedingly difficult.

A tripod drill operated in connection with a stationary steam plant was first tried by the contractor, but with poor results. The seaminess of the rock interferred with drilling by causing the drills to bind, necessitating more frequent blasting. This necessarily slowed up the work and made it more costly, as more powder had to be used and the drilling equipment had to be removed and reset more often. Looking for a solution of the problem the contractor experimented with hammer drills operated by compressed air. The result was considered satisfactory from both operating and cost points of view.

While hammer drills are in general use in

mining operations, their adaptability to road work is not widely known among highway contractors and engineers. The drill employed on this work was a large type of the common hand drill and used a hollow steel of hexagonal shape through which air was discharged for the purpose of removing the dust and stone cuttings under the bit of the steel. The contractor reports that he has since used an automatically rotating drill in similar rock work with even better results.

Although the average depth of the holes was about 8 ft., holes were occasionally drilled to as great a depth as 12 ft. in sound stone without the binding action being noticeable. A short steel or starter, from 1 to 1½ ft. long, was first used with a bit considerably larger in diameter than the steel itself. Successive steels, each about 1 ft. longer than the preceding, and each with a bit slighly smaller in diameter, were used until the desired depth was reached. In the early operations with the tripod drill the bit had frequently been forced through thin layers of rock under the action of the heavy blows to which the drill was subjected in much the same manner as an auger penetrates a thin piece of wood. This tended to reduce the diametral dimensions of the hole, make it irregular in shape and bind the drill. The lighter and more frequent blows of the hammer drill, which is dependent on its own weight and not on forced cranking for its feed, gave it a tendency to rebound and eliminated the binding action when penetrating alternating hard and soft strata.

Another advantage observed was the ease in setting up. Very little time was required to move from one point to another and as much as 240 ft. were drilled by two hammer drills, each operated by one man, in a day. Where a hole close to the embankment was necessary to distribute the shot properly, the hand drill could be started with no more preliminary trouble than if the shot was to be placed in the center of the cut. There were no limitations in its use as to inclination of hole, but a maximum depth attainable with only one drill operator was 12 ft. A greater footage of holes was drilled with the hammer drill than was economically possible by the other methods, and with a greater number of holes the rock was broken into smaller pieces and of better size for removal in dump carts.

The hammer drill was connected to an Abenaque portable air compressor outfit which comprised a 20-hp. horizontal, four-cycle, gasoline engine mounted on a steel frame and direct-connected to an Ingersoll-Rand air compressor. The whole was mounted on wheels and followed closely the work of the drillers as they progressed through the cut. When not in use on the drilling work the outfit was moved to a nearby rock crusher, the compressor disconnected, and the engine belted over a friction clutch pully to the crusher and employed in breaking the rock used in the foundations for the macadam construction.

Water for the work had to be drawn in tanks from Depauville, 2 miles distant. A saving in cost of this account was noticeable as compared with steam-operated drills, as the outfit required only 2 bbl. of water a week for use in the cooling system of the engine. Approximately 18 gal. of gasoline were required for one ten-hour day run. The work was done by Coleman Brothers, General contractors, of Boston, Mass.— *Eng. Record.*

CONTRIBUTORY NEGLIGENCE

In a personal injury case, the plaintiff, who had been cleaning the flues of a boiler, was injured by the unexpected starting of a rotary motor, driven by compressed air, caused by the opening of a lever valve in a double connection attached to a movable hose. The jury returned a verdict for the plaintiff, and found specially that the defendant's negligence consisted in using a valve without a locking or safety device, and that they did not know what caused the valve to open. On appeal it was held that the fact that a screw valve was provided at another point by which the plaintiff could have cut off the compressed air was not fatal to his right to recover, since to have used that valve would have cut the air off from another machine as well as from that which he was using. Although the jury were unable to say in what manner the valve was opened, their verdict was sustained on the ground that it was a fair question for their determination whether, under all the conditions shown, it was negligence to use a lever valve without a locking device in a situation such that it might in various ways be accidentally opened.

Wells v. Swift & Co., Kansas Supreme Court, 133 Pac. 732.

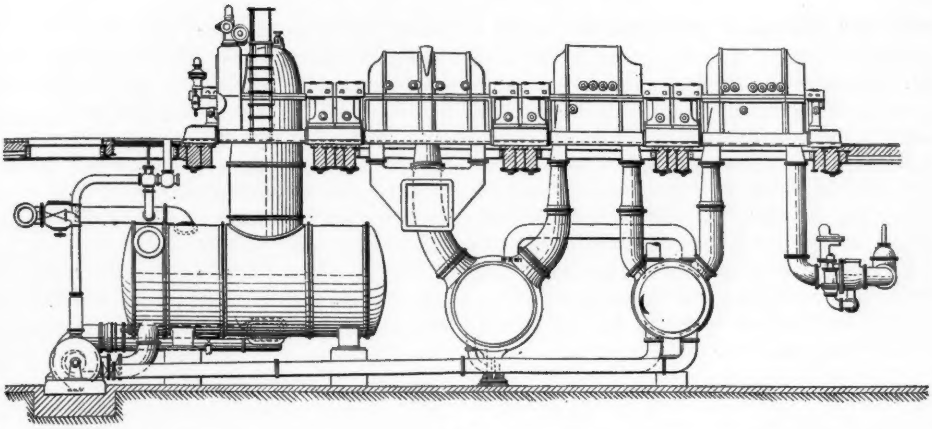


FIG. 1

A LARGE TURBO-COMPRESSOR

BY DR. ALFRED GRADENWITZ.

A short time ago a remarkable turbo-compressor was completed at the Allgemeine Elektricitäts Gesellschaft turbine factory, with a capacity of 3,531,400 cu. ft. of free air per hour compressed to 140-170 lb. per sq. in. This corresponds to a power output of 12,000-13,000 b. h. p.

This is one of three compressors of the same capacity to be supplied to the Victoria Falls & Transvaal Power Co. This company was the first to avail itself of the advantages afforded by turbo-compressors of large size and to adopt the transmission of power on a large scale by the agency of compressed air. The company already has twelve 4000 h. p. turbo-compressors in commission in its power stations near Johannesburg. The compressed air from these machines is transmitted through a pipe line 18.6 miles long, supplying 17 mines for operating rock drills and other air operated tools. The installation of the three large compressors will raise the total amount of energy transmitted by the compressed air to 84,000 h. p.

Fig. 1 shows the general arrangement of the compressor here spoken of. The steam turbine is on the left hand side. This is designed for high pressure, superheated steam, and is fitted with automatic nozzle regulation. This is understood to be the first turbine built to give an output of 12,000 h. p. at a speed of 3000 r.p.m.

The compressor, consisting of three cylin-

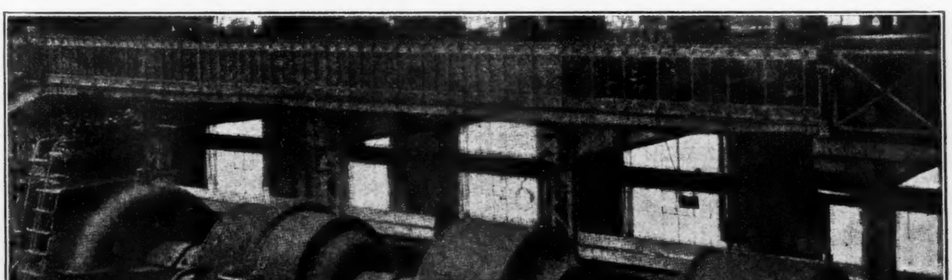


FIG. 2.

ders, is connected to the steam turbine by a flexible coupling. The low-pressure air cylinder is next to the turbine, and in view of the large quantity of air handled, is designed to draw in air on both sides. The air passes from the main suction pipe, the square section of which is visible in Figs. 1 and 2, into the two ends of the low-pressure compressor, passing out to the intermediate cooler, slightly compressed at a temperature of about 100 deg. C., in which it is cooled to about 30 deg. C.

The intermediate cylinder, through which the air next passes, is constructed with an intake on one side only, as the volume of air has been so reduced that it is no longer necessary to divide the air current on account of the suction of the impellers. The air compression is further increased in this cylinder, and the air passes out of it in a highly heated condition, to be coooled again in a second cooler, Fig. 1, whereupon it enters the high-pressure cylinder for final compression and is then discharged to the pipe line through the pressure pipe shown in Fig. 1, on the right.

As the cooling effect in the intermediate coolers is not sufficient to permit the process of compression to be carried out economically, the compressor cylinders themselves are water cooled. The pipe lines through which this water is brought is shown in Fig. 2, which is a view of the compressor on the test bed.

The light foundations upon which the turbo-compressor is erected are especially noteworthy. They permit the intermediate coolers with their piping and the condenser plant for the turbine to be installed conveniently below them in the basement.

This first 12,000-hp. compressor, on test, satisfied the guarantee conditions for steam consumption, which were more severe than would have been thought possible for units of 1000 to 2000 hp. The units ran on the test bed for several hours with a load up to 12,000 hp., corresponding to normal working conditions.—*Power.*

ROCK DRILLING IN LAKE SUPERIOR IRON MINES

BY P. B. MC DONALD.

The present status of the rock drill in the Lake Superior iron mines is much different from that of a few years ago when nearly all drilling was by the two-man, mounted, reciprocating machine. The stope drill is now used for practically all the raise work requiring a power drill. The cost of raising has been generally reduced to less than half the former cost. It is probable that the stope drill has worked greater economies than any other type. On account of the mass-like shape of the large iron ore deposits, raising is an important part of many of the mining methods in vogue.

The one-man, mounted, reciprocating drill for driving and stoping (over which there was so much controversy in the copper country) has had a number of sales in the iron region, and was an efficient drill for the "medium soft" grades of ore. It was repeatedly demonstrated that one man could accomplish the same (or greater) drilling results with this drill as previously had required two men with the old type, heavy drill. However, a new development has taken place in this line in the iron region. Unlike the tough copper country rock, the majority of the iron ore is medium soft or soft, some of the latter varieties on the Mesabi range having been drilled with hand augers for years. It has been found that a small, automatically rotated, "plug" drill, changed so as also to be used as a power auger, is possible; that is, such a machine will work as an auger in soft ground but when a hard seam is struck it changes to a hammer drill. This new style of drill promises to be a decided success, and is expected ultimately almost to replace the one-man piston drill in the iron mines.

The general use of smaller and lighter drills in driving and sinking is resulting in a trend to the European practice of shorter holes, better placed, and a shorter cut; it is found that with cuts of 4 or 5 ft. progress can be made faster than was formerly possible with 6-ft. cuts; the light drills permit greater flexibility in pointing the holes, and can be quickly moved back out of the way for blasting, thus encouraging more frequent blasting.

[This reference to European practice is scarcely applicable as that has to do with tunnel work, which is essentially different from mining.]

For drilling the unusually hard ores and for the hard rock sometimes accompanying the iron ores, such as jaspilite and quartzite, the two-man, reciprocating drill will be retained. Another type of drill which has been successful in the hard rock (more especially

true in the copper country) is the Leyner drill. This can perhaps be called a hybrid type because it is a hammer drill and at the same time is mounted on bar or tripod; the water principle of washing out rock chippings is, of course, an important feature.

In sinking, a radical change has come about. In place of the two-man, piston drill on tripod or bar, little "plug" drills are now used. Three-quarters of the shaft sinking in the iron region is now done by automatically rotated plug drills or "hand sinkers," and records are being made in speed of sinking.

On the Gogebic range, the Newport Mining Co. recently sunk an 11 by 18 shaft in quartzite 33 ft. in one week, with Jackhamers, and the concrete lining was put in at equal speed. Contrary to first expectations these little hand sinkers can put down deep holes when necessary. Their principal advantages lie in their one-man principle, enabling twice the number of drills to be used in a shaft, and in the ease with which they can be removed for blasting. —*Mining and Scientific Press.*

PRACTICAL NOTES ON THE PULP-AIR-LIFT

BY A. M. MERTON.

Not long ago a well-known practical mill man, who was being shown around a mill, then in course of erection, commented on the air-lifts. His advice was to discard them, and replace by some kind of pump or elevator. His own experience has been unfavorable. The man who was to take charge of the mill, as foreman, was also dubious; the experience he had had with them, working under another engineer, was not satisfactory.

Again, in one of the most up-to-date mills on the continent—one in which the practice was carefully worked out by several years' preliminary work on a smaller mill—the air-lift is conspicuous by its absence. All wet pulp is raised by bucket-elevator. These brief statements outline the general attitude towards air-lifts. Some engineers are more than a little afraid of them. It is, however, interesting to note that in the mill first referred to, the air-lift worked most successfully, and that, in the latter, a modification in the treatment required elevation of the pulp in a part of the mill where no provision was made for such elevation; an air-lift was tried out and worked so successfully and economically that the present intention is to replace the bucket-elevator by air-lift wherever possible.

There have been many failures in the use of air-lifts for elevating pulp. Nothing is heard of these failures, owing to the fact that most of them were on a small or experimental scale. It is clear, then, that the principles on which the pulp-air-lift works are not well, or generally understood. The practice in lifting pulp differs in certain particulars from the air-lift which merely raises water. The failures are due to not appreciating these differences.

In regard to the principles on which air-lifts work there is still a general misapprehension among mill men. Many believe that the liquid is raised in the lift pipe by the medium of "pistons" of air thrusting the fluid upwards. In a properly designed and operated air-lift, this is incorrect. In a well-arranged lift the flow of pulp is steady and even, showing that pistons of air do not occur. When the pulp is delivered in spurts, the air-lift is working inefficiently.

The air-lift merely works on the principle of the hydrostatic balance; the fluid in one limb being lightened by the introduction of air. For example, take a U tube, Fig. 1, 4 ins. in diameter, with one limb 24 ft. long, and the other 36 ft.; it will hold about 4 cu. ft. above the bend. Now into the long limb of the U tube pass a stream of air bubbles, so that at all times there is one cu. ft. of air in it. Each sphere of air will displace an equivalent volume of water, and of course the water will rise in the long limb until the volume is that

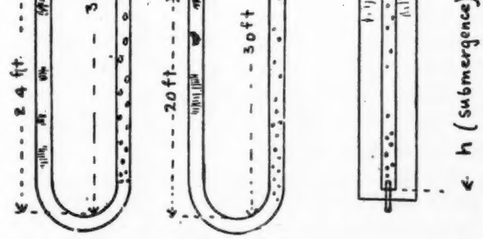


FIG. 1. FIG. 2. FIG. 3.

of the combined air and water; or in this case it will rise 12 ft. without in any way affecting the water level in the short limb. Thus we see that 24 ft. of water will balance 36 ft. of an aerated fluid containing 30 per cent. of air by volume. Now if the long limb is cut 6 ft. below the top of the pipe, Fig. 2, the water will flow out under a head of 6 ft. (or with an initial pressure of about one-fifth pound per square inch in this case) until the level stands 4 ft. lower in the short limb, when the flow will cease. Thus we have again 20 ft. of water balancing 30 ft. of mixed water and air, and if the short limb is continuously supplied with water, the longer limb will have a steady stream of water issuing from it. There is no necessity whatever to assume the presence of air pistons. The little bubbles of air displacing an equivalent volume of water are not only sufficient to do the work, but experience has shown that they act more economically than the pistons.

All this is rudimentary, but it must be understood, if clear ideas are to be held regarding air lifts. But in air lifts for elevating pulp, other questions have to be considered To neglect these questions is to invite failure.

Pulp is a mixture of sand, clay and water, or cyanide solution. It is clear that, in raising such a mixture, the velocity upwards must be great enough to lift the coarsest particles in the pulp. Otherwise there will be a sorting action in the lift—the lighter particles being carried upwards and the coarser left behind—and the gradual accumulation at the bottom of the pipe will eventually choke it.

The operation of an air-lift discloses the fact that the screens and classifiers of a mill allow, in some manner, the escape of a very small percentage of very coarse particles. For instance, in one plant treating 4,500 tons of slime a month, 80 per cent. of the slime passing a 150-mesh screen, there accummulated, in one part of the system, about 1,000 lbs, of coarse ore every month. Or at least that amount was removed. There was reason to believe that the actual amount present was greater. The particles varied in size from rice, to a small bean. Screen analyses never detected their presence.

In considering air-lifts, therefore, the upward velocity of the current must be great enough to carry off very large pieces of ore, otherwise the air-lift will give periodical trouble by choking. Considerable experience with air-lifts has shown that the velocity of the pulp in the rising limb must not be less than 2½ ft. per second and that to get good results 5 ft. per second would be better.

In every case of a failure of which I have any specific knowledge, the fault has been in having too large a rising pipe. A large pipe, in carrying water, of course, means a low loss by friction; but it also means a low velocity of water in the pipe. In an air-lift elevating pulp, the velocity upwards is fixed by the character of the pulp and cannot be reduced. The loss due to friction cannot be eliminated

The next error is in providing insufficient air to properly operate the lift. Mechanically the air-lift is most inefficient. Generally 3 times as much air is required to raise a given quantity than is theoretically necessary. It is safe to say that twice the amount of air is required to lift a mill pulp than the tables give for lifting an equivalent amount of water. Of course, it is to be understood that these statements are approximations.

REQUIREMENTS OF AN AIR-LIFT.

Turning now from general considerations, let us consider the specific requirements of an economical air-lift:

Usually the air-lift takes the form of 2 tubes, one within the other. The outer pipe acts as a well, while the smaller inner pipe acts as the riser, and takes the place of the long limb in the U-tube. In the diagram (Fig. 3) H is the height of lift; h is the feet of submergence; H plus h is the total length of the riser. It has been found by experience that h should be at least 60 per cent. of the quantity H plus h, to get economical results. In actual mill work it can be as low as 45 per cent.

The air pressure required is calculated from the formula:

P=pressure;
S.G.=specific gravity of pulp;
h=submersion.

P=433, S.G., h.

Actually a few pounds extra pressure are required to overcome friction, say from 3 to 4 lbs.

The amount of air required depends upon the design of the lift and the percentage of submersion. Too few data are at hand to safely theorize upon this matter. Actual test has shown that 2.5 cu. ft. of free air per cubic foot of pulp to be raised is the least that should be provided. In a specific case 3.2 cu.

ft. air were required to raise 1 cu. ft. of a pulp containing 28 per cent. solids. For a new plant where actual data are wanting it is safe to say that a compressor capacity of 3.5 cu. ft. of free air by piston displacement per cubic foot of pulp to be raised is the least that should be provided.

In selecting a compressor it is a mistake to have too high a pressure. If the requirements are for 20 lbs. pressure, the delivery of air at 30 lbs. is mere waste of power. It has been said that an air-receiver is not necessary. This may be so, theoretically. Still a large receiver is necessary when the air is being used for a great variety of purposes. Also, practically, it acts as an oil trap, the value of which, in a cyanide or concentration plant, cannot be gainsaid. There are air-cooled compressors on the market for low-pressure air. These have been used with satisfaction, but often they consume too much oil to be good machines for metallurgical purposes.

Lastly, in considering mill work it should be remembered that the requirements for economy cannot be strictly followed. Where there are a number of lifts, agitators, etc., to be operated from the same compressor, the requirements of each must be different. Thus one may only require 10 lbs. pressure while another may demand 28 lbs.

The efficiency of air-lifts has been reckoned to be from 40 to 50 per cent. In actual practice the economy can only be reckoned as about 35 per cent. Especially where many lifts working under different heads are joined up to the same compressor.

However, in spite of the low mechanical efficiency, the absence of moving parts, the cheapness of the material used, and the compactness of the apparatus all make the well-designed air-lift the most economical means of lifting pulp that we now have.

The actual design and construction of an air-lift should be as simple as possible. Elaborate designs for maintaining a uniform submergence, by regulating the air inlet by means of floats, etc., are valueless. They may be, indeed, a detriment. Complicated foot-valves for delivery of the air at the bottom of the riser, are also not only unnecessary, but frequently are a nuisance.

So far as the air-jet is concerned, it may simply be formed by the open end of the pipe looking downwards. Where the attempt is made to use the air as a jet, as in an injector, there is always bother when the plant is closed down. The upward nozzle fills with slime, forming a plug, which even high-pressure air will not always expel. Then the messy and disagreeable task of opening the bottom of the lift is before the mill men. The value of low pressure air as a jet is probably negligible. The simple valve formed by a piece of rubber tube at the end of the air-pipe is as effective as any of the more complicated jets, etc.

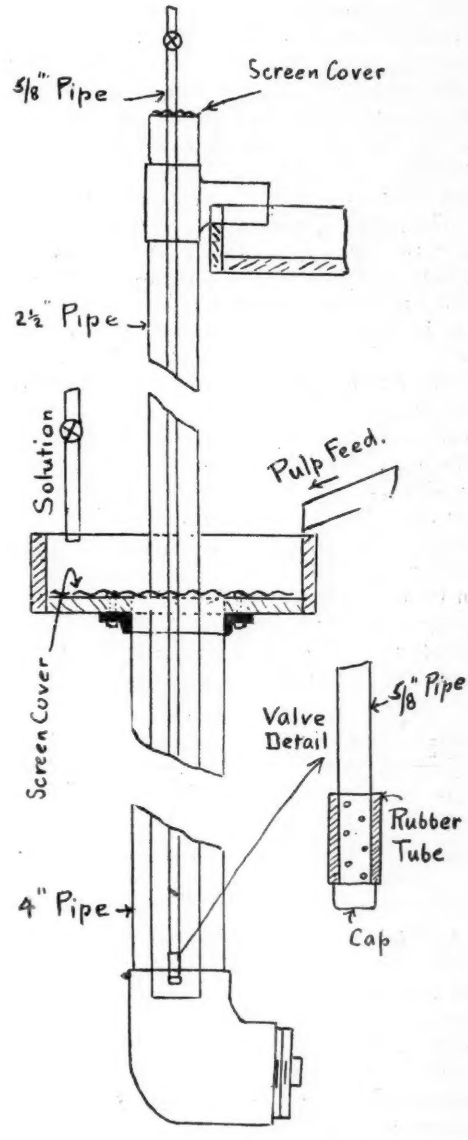


FIG. 4.

In the design given, Fig. 4, every requirement of actual operation is met fairly well. It need only be stated that, when closing down the mill temporarily, a good deal of trouble can be avoided by shutting off the flow of pulp to the lift, and turning on a flow of water or solution. The slime, at least, is washed out and the lift can be easily started again.

The practical mill man opens up the lift before sending a flow of pulp to it, using the water or solution instead, to insure the fact that there is no stoppage. Then the stamps can be dropped with assurance that the pulp will be taken care of.

The following table shows the requirements of various volumes of pulp. Those marked with an asterisk are details from actual cases. The capacities of the various lifts are approximations for submergencies of 45 to 60 per cent. Under practical conditions, the submergence is constantly fluctuating. If the submergence is increased (owing possibly to an increased rate in the feed of pulp) the capacity of the lift is increased, and the air consumption will be diminished, and vice versa when the submergence is decreased.

AIR LIFT DATA.

Rising main. Ins. diam.	Well pipe. Ins. diam.	Air pipe. Ins. diam.	Pulp cap. Cu. ft. per min.	Free air required. Cu. ft. per min.
*1	2½	⅜	1.25	4
1½	3	⅜	3.50	11
*2	4	½	6.60	20
2½	4	⅝	10.00	30
*3	5	¾	15.00	50

Test—A 3-in. air lift, submersion 50%, Pulp 28% solids, gave delivery of 1200 lbs. pulp (15.5 cu. ft.) and consumed 48 cu. ft. air per minute.

AIR-LIFTS DRAWBACKS.

Air-lifts have their drawbacks. First there is the submergence to be provided for. In a flat mill site, this is a serious matter. In a terraced mill, part or the whole of the submergence can be obtained at the edges of the benches. Also they do not accommodate themselves to very wide ranges of capacity. For example, if in a 20-stamp mill one lift is provided for all stamps, when 3 of the batteries are hung up, the lift will probably not work well on the small amount of pulp delivered by 5 stamps only. The remedy of having 2 lifts in this case, is obvious.

A well-designed lift intelligently operated, is safe, simple and economical. But mill men must understand that an air-lift cannot be made by putting together 3 pipes one inside the other. The conditions mentioned must be fulfilled. When they are, an air-lift is by long odds the best pulp elevator we have; when they are not, it is an abomination.—*Mining and Engineering World.*

PHENOMENAL SAVINGS IN DRILL SHARPENING

The following is from a special Cornwall correspondent of *The Mining News*, London. He speaks of the necessity of reducing the cost of output in the tin mines, especially in view of a possible reduction in the selling price of the metal. He says:

In only three ways can such a contingency be met—*i. e.,* either by larger output to mill, increased recovery from orestuff, or reduced working costs. At present I propose to deal only with the last mentioned and, while recognizing that increased output means automatically reduced working costs, still there are certain costs which *per se,* whether output be small or large, are susceptible of reduction. To mention only one of these items, take blacksmiths' costs, which at most mines are far in excess of what they should be.

HAND SHARPENING BEHIND THE TIMES.

In underground work hand drilling has largely given way to the air-driven rock drill, not only because it reduces actual costs, but because it gives far higher efficiency, and yet we go on making and sharpening bits by hand at a high cost and for a low efficiency as though nobody had ever heard of a mechanical drill-sharpener, air driven, which makes a perfect bit in one minute and renders the mine independent of that aristocrat, the smith, who knows how to temper and sharpen a bit and takes very good care that everybody else recognizes his superior abilities. The "Leyner" drill sharpener and "Leyner" oil furnace together form an equipment which should be on every mine running over three drills. Neither machine requires foundations, both are compact, occupy little space, and are easily moved, the sharpener being about half the weight of others on the market, whilst in the matter of rigidity and strength it has no superior. Best of all, the machine is, practically, fool proof and requires no highly-skilled blacksmith to work it. Not only does it make a perfect bit in one minute, but it sharpens as no smith can sharpen, and that from the plain chisel bit to the complex two, or difficult five-point star. Further, it shanks any form of steel used for piston or hammer type drills and may be used

for heading bolts, pins, and spikes, and forming a great variety of special tools.

ACTUAL SAVINGS BY MACHINE SHARPENING.

As an instance of the economy effected by the use of the "Leyner" I will quote the experience of a European mine where one of the old type machines was installed. Formerly the mine kept a stock of 1,000 steels for use with their drills; now they only need about 600. By the old hand method the waste of steel was, roughly, 22 lb. per day. With the "Leyner" this waste was avoided, the steel being reforged and a saving of 6s. 8d. ($1.66) per day effected, three men were dispensed with and a saving of 7s. 6d. ($1.88) per day effected; charcoal cost is 1s. 8d. ($0.42) per day less, thus bringing the total saving up to 16s. 8d. ($4.16) per day, and that with an old-type machine and in a country where wages are considerably lower than in Cornwall. Three hundred days' working of that machine paid its cost and gave higher efficiency in rock-drilling. What would a new type machine effect on a Cornish mine and why is one not seen in action on every mine where rock drills are used? Possibly there is no need to economize in our mines, or it may be that the "Leyner," not being of local manufacture, has failed to secure the glad eye so generally reserved for native merit.

ELECTRIC SWITCHES IN GASEOUS MINES

The flash resulting from the opening of a 250-volt direct-current circuit carrying more than half an ampere will ignite explosive mixtures of mine gas and air. An equally dangerous flash may be produced by even less current from a 500-volt circuit. Few mine electric circuits carry less than half an ampere when in use. The need of protecting the switches of such circuits in places where gas is likely to be present is therefore obvious.

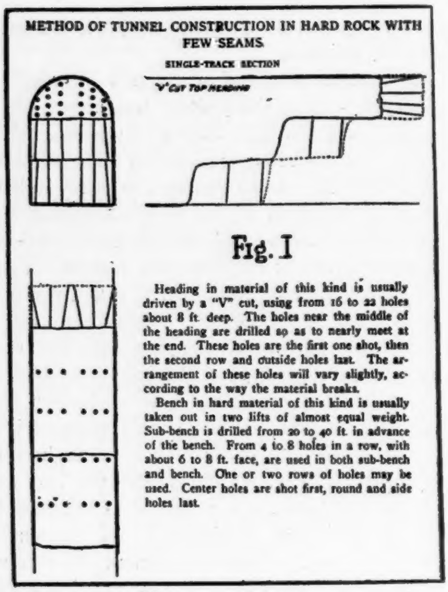
Two general methods have been proposed for preventing switching flashes from igniting gas surrounding the switch. One method is to inclose the switch in a casing provided with openings that are covered with wire gauze or otherwise designed and equipped for preventing the passage of flames from the interior to the exterior of the switch casing. Switches so protected are called explosion-proof switches. The second method is to immerse the switch contacts in oil to a depth sufficient to quench any flash that may occur when the switch is operated. Switches so protected are called oil switches.

The success of the first method of protection depends upon the proper design and construction of the switch casing. It is essential to the successful operation of the second method that the switch contacts be surrounded by the proper kind of oil in good condition. There are several ways in which an oil switch may be deprived of its protective feature. The oil tank may not be filled, or, if filled, the oil may leak out or be spilled. The oil tank may be removed (in some designs) and not replaced, or through neglect the condition of the oil may become such that it is no longer an efficient protection. While such contingencies are not likely to occur, and although oil switches may be so designed that the loss of oil is not probable, nevertheless, as compared with oil switches, explosion-proof switches seem to possess a greater element of safety because their protective features are inherent in their construction, and for that reason are not likely, when needed, to be missing or impaired if the mechanical construction of the switches is sufficiently durable. Moreover, switches of the explosion-proof type can be so designed that the condition of their protective features may be readily observed each time that the switches are operated.

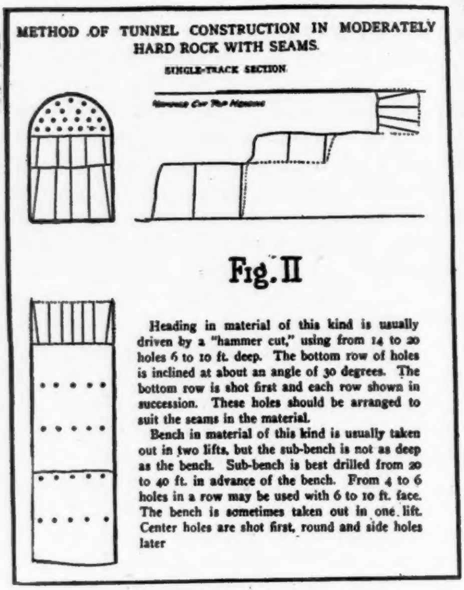
The above are the opening paragraphs of Bulletin 68, just issued by the Bureau of Mines of the Department of Agriculture which may be had free by any one who will write for it. It describes a series of carefully conducted tests of electric switches and is liberally illustrated.

A NEW JOB FOR PNEUMATIC HAMMERS

In the process of annealing in steel sheet mills the sheets go into the ovens in large bundles, and when they are taken out they are stuck together so that it is difficult to separate them. By striking the bundles with iron or soft hammers it is possible to break up the mass into packages, say three-quarter inch thick, from which the individual sheets must be separated by hand, using crescent shaped spreaders. A series of tests with specially designed pneumatic hammers has produced gratifying results and showed that it would be advisable to pipe the floor with compressed air even for this service alone.



V CUT HEADING.



HAMMER CUT HEADING.

ECONOMY IN TUNNEL DRIVING

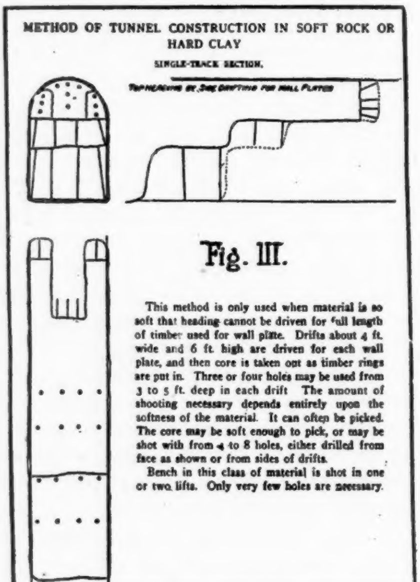
In the report of the committee on roadway at the Chicago convention of the American Railway Engineering Association, it was said that railway tunnels, as ordinarily constructed in the United States, are more economically built by first driving the heading entirely through, although this method generally requires a greater length of time for the completion of the job. They say further:

That it is economical and expedient to use an electric shovel or an air shovel for the removal of the bench where the section of the tunnel permits the safe operation of the same; and that where the material does not require support, there are advantages in low cost and quick removal of the bench in driving the heading at the subgrade line.

That where the time limit is of value, the heading and bench should be excavated at the same time, the heading being kept 50 feet in advance of the bench. Where the material of roof is not self-supporting and timbering is to be resorted to, the bench should not be removed until the wall plates are laid and the arch ribs or centering safely put up.

That opposing grades should not meet between the portals of a tunnel, so as to put a summit in the tunnel, and where practicable, the alinement and ascending grades in the tunnel should be in the same direction as the prevailing winds.

The three cuts herewith are representative of American practice in single-tracked tunnel construction where the time limit is insistent; Fig. 1 showing the V-cut heading; Fig. 2, the hammer-cut heading and Fig. 3 a top heading by side drifting for wall plates.



SIDE DRIFTING.

A MUNICIPAL AIR LIFT PLANT

The water supply of any city is never without its features of interest from an engineering view point, and each city differs from every other in some particulars, while the range of divergence both as to the sources of supply and the means by which the supplies are made reliably available is practically unlimited. Those cities are most fortunate which have pure water within reach even if special arrangements are necessary for securing, storing and distributing it. The city of Savannah, Georgia, has had its share of experience with its water supply and is now in a position to congratulate itself upon the outcome.

Until about 35 years ago all the water for the city service was pumped from the Savannah river, the supply only limited by the pumping capacity, but the quality no better than that of other full grown rivers. Then 15 flowing wells were bored about two miles out of the city, the water being then pumped into the city mains under the required head. This was called the "River" plant. In 1892 another plant was established with 13 wells about a mile and a half away, known as the "Gwinnett Street" plant.

As other wells were constantly being drilled in and around the city the wells which originally flowed a half million gallons in the 24 hours from each well finally stopped with the water 12 ft. below the surface. The suction from the pumping engines was connected to the wells with results far from satisfactory or reliable. In 1902 a steam driven Corliss compressor was bought from the Rand Drill Company, size 18 and 28x20x36 for operating air lifts. This compressor was run with a surface condenser and showed good power economy. The next year a duplicate of this machine was bought, these both being placed in the Gwinnett Street plant. In 1913 the underwriters conducted a test, and on a one hour's run they pumped at the rate of 18,000,000 gallons in 24 hours.

The River plant was operated in connection with the Gwinnett Street plant by using a compound steam pump until 1908, when an Ingersoll-Rand Imperial Corliss condensing compressor was installed, 14 and 24 and 20x20x20 in., and this machine has since been used as a booster to the Gwinnett Street plant. One machine is run for a month at Gwinnett Street and then the other is run for

AIR LIFT DISCHARGE BASIN.

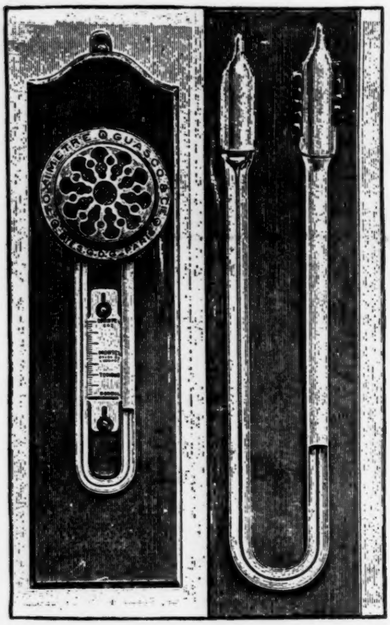
a month, while the River plant machine runs from two to six hours a day as required. The wells at Gwinnett Street are all 12 in. diameter and are not reduced; those at River Station are some 4 in. and some 6 in., and the working air pressure is about 50 lb., gage.

The total cost of pumping at Gwinnett Street, including the pumping into the mains, based on actual cost including operation and repairs but not depreciation or interest, is at the rate of $9.90 per 1,000,000 gallons. Here they use crank and fly wheel Corliss pumping engines; at River plant, using pumps not as economical and operating only intermittently, the pumping costs are higher.

At River plant they were pumping at the rate of 1,000,000 gallons per day; after putting in the compressor they reached a rate of 8,000,000, but ordinarily the rate is maintained at 5,000,000. The half tone, which does not tell us much, was taken at the River plant

A MOTOR TRUCK RETARDER

The manufacturers of a French motor truck have added to it an air brake of novel principle. It might more properly be called a retarder or controller, its most essential element being a fan, like that used in the mechanism of striking clocks. When the motor truck is on a long down grade, on which continued application of hand or emergency brakes would burn the brake lining, the driver pulls the "air-brake" lever. The revolving shaft acts by means of a bevel gear upon a wide-bladed large fan mounted horizontally below the body of the truck. The resistance of the atmosphere to the forward motion of the fan blades retards the shaft revolutions sufficiently to brake the truck.



SENSITIVE GAGE FOR MINE GASES.

GAGE FOR POISONOUS GASES IN THE AIR

A gage which will show the presence of poisonous gas in the atmosphere in a proportion as low as 1 to 10,000 has been invented by a Frenchman named Guasco, who has named it the "toximeter," a designation far from original.

It is described in *La Nature* by G. Chalmares, who notes that it is intended particularly to give warning of the presence of carbon monoxid—the gas that burns with a blue flame in a freshly made fire of anthracite. The greatest care, Mr. Chalmares remarks, must be taken, in the installation of a heating or lighting plant, to avoid the production of this substance. He writes:

Other gases, such as carbureted hydrogen and acetylene, happily betray their presence by their odor long before a fatal dose is reached. It is not so with carbon monoxid, which has no odor and is very poisonous, even in very slight quantities. For this reason many attempts have been made to discover means to make its presence konown in air intended for respiration, before fatal consequences have been reached. Chemical reactions have generally been employed—a delicate process, sometimes too sensitive, necessitating manipulations which, although simple enough, can not always be performed.

Mr. Guasco has conceived the idea of utilizing the property possessed by platinum sponge of becoming rapidly heated in the presence of carbon monoxid, which it absorbs in large quantities. This property has been practically utilized for several years for lighting gas-jets and for a long time past in the hydrogen briquet. He has thus invented a device necessitating no manipulation. It is formed of a Leslie's differential thermometer, which, as is well known, is a U tube ending in two bulbs full of air; a mercury column or a section of colored liquid is displaced in the tube at the slightest difference of temperature between the two bulbs. Mr. Guasco fastens to one of the bulbs ten pastilles of platinum sponge; the corresponding side of the tube is covered and the other branch is graduated. When the apparatus is in a medium containing corbon monoxid, there is a difference of temperature, revealed almost instantly by a movement of the column, which is greater and more rapid the more of the poisonous gas there is in the atmosphere. Evidently other gases, illuminating gas, for instance, will have the same action, but they will also betray themselves by their odor. It is thus for carbon monoxid that the indications of the toximeter will be valuable. The (French) Inspector-General of Mines has presented the device to the Academy of Sciences, after having experimented successfully.

On his part, Mr. Guasco has made numerous experiments from which he finds that the movement of the gage in the U tube is about half an inch for the proportion of 1-1,000 of carbon monoxid, which makes it possible to use graduations that will show 1-10,000 of the toxic gas.

In a special model, the inventor has used mercury for the indicating column and has placed a platinum contact-point in the tube. This closes an electric circuit and operates either a bell or an incandescent lamp, thus giving notice, even at a distance, by sonorous or luminous signal, that there is danger from the abnormal presence of poisonous gas.

Compressor, chipping hammer, sand rammer, molding machine, sandblast, sand riddle and air hoist, have become parts of every well organized foundry.

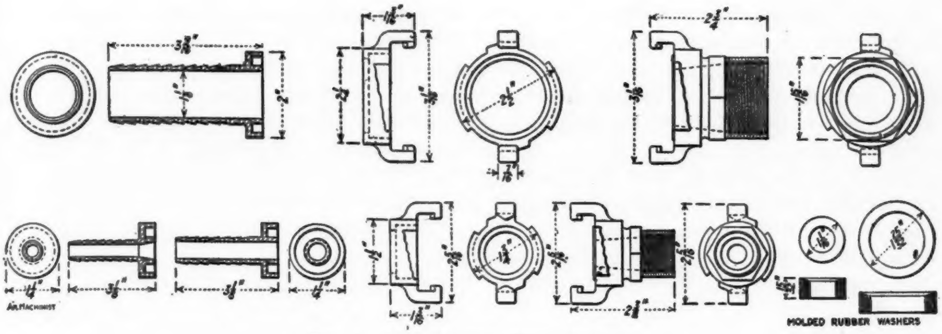


FIG. 1. QUICK-ACTING HOSE FITTING

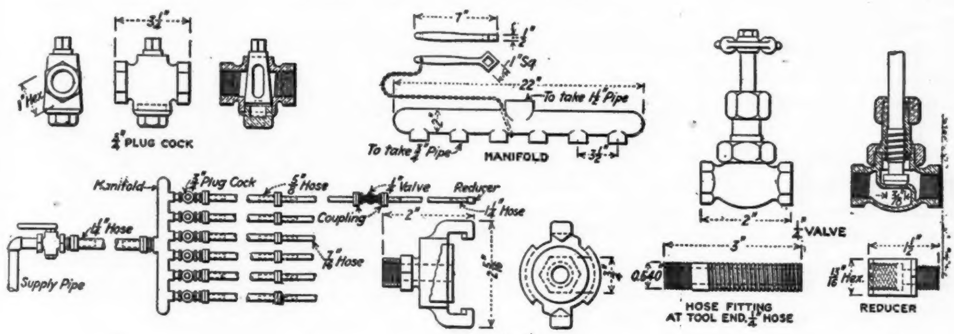


FIG. 2. METHODS OF CONNECTING UP AIR HOSE

COMPRESSED AIR HOSE FITTINGS

BY G. A. BISSEL.*

The Hull division of the Portsmouth Navy is now entirely equipped with the universal quick-acting hose fittings and manifold fittings, as illustrated in Fig. 1, which have been invented and developed by me. There are nearly 3000 of these now in use. The couplings differ from other universal couplings in that as the rubber washers become old or worn, the coupling can be set up another notch, the cam on which the lugs bear having five locking points.

An ideal layout for a shipyard or navy yard is shown in Fig. 2, the $1\frac{1}{4}$-, $1\frac{5}{8}$- and $1^{1}/_{16}$ in. hose being the three standard sizes now used in all navy yards. Fig. 2 also shows, on one section of hose, a valve located close to the hammer. This arrangement is frequently used when the air manifold is located on deck while the workman is below decks. Instead of having to go up on deck to shut off the air at the manifold, he can shut it off at the nearby valve.

It is found that the new couplings have admirably fulfilled the purposes for which they were designed, namely, first to avoid leakage of air; second to economize the time of the workman; third to require little care.

The rubber washers on the old couplings were constantly being blown out and lost. This difficulty is obviated in the new coupling.

The manifolds shown in Fig. 2 are provided with cocks for operation with a handle. Only one handle is provided for each manifold. It was found that when handles were provided for each cock they were in the way and frequently became bent so as to interfere with their operation. The type of cock shown is that found most satisfactory. The nut at the bottom serves to increase the pressure on the springs, when necessary, to prevent the cock from leaking. It is not on the spindle of the cock, consequently there is no tendency to unscrew it when turning the spindle. The usual type of cock has a nut on the spindle—this is objectionable as it makes it leaky after a short period of service.—*American Machinist.*

*Naval Constructor, U. S. N., Portsmouth, N. H.

WHISTLE SIGNALS*

1. Steam-shovel engineers must be conversant with all warning signals, and it is made the responsibility and duty of each engineer to give warning of all blasting in the vicinity of his steam-shovel.

2. Sound of the whistle must be distinct, with intensity and duration proportionate to the distance signal is to be conveyed.

3. Each shovel must be equipped with a distinctive toned steam whistle. All shovels are numbered plainly, with a number in full view from all parts of the workings. Employees must familiarize themselves with the distinguishing sound of the different shovel whistles in order that they may readily locate blasting operations and be prepared to safeguard themselves from possible danger of flying rock and debris.

4. Powdermen and blasters must not "spit" or light a fuse or fire a charge until after the alarm and warning signal has been sounded by the shovel engineer.

5. Signal for blasting shall be a series or succession of short, sharp, quick blasts of whistles, continued for brief period, to be followed immediately by as many long sounds of whistle as there are shots to be fired. To illustrate: if there are 10 shots to be fired, the nearest shovel will sound the alarm series of short, quick "toots" of the whistle, followed after a brief interval by 10 long sounds, indicating 10 rounds or shots to be exploded.

6. The signal prescribed and herewith set out are illustrated by the word "short" for short sounds, and the word "long" for long sounds or blasts of the whistle:

SOUND.	INDICATION OF WARNING.
1 long, 1 short	Beginning and end of shift.
2 short	Move up shovel.
3 short	Calls waterman, pipemen, and lighters.
4 short	Calls powderman.
5 short	Calls foreman.
Series short, quick	Warning signal—blasting.
Followed by number of long	Indicates number of shots to be fired.
2 long	Round or charge of blasting completed.

The signal for "seam" shots, distinguished from bore-hole shots, top blasting, or bull-dozing, will be the regular alarm signal followed by whistle sound of longer duration than the long signal indicating number of shots to be fired. While a seam shot may not be more dangerous than other blasting, the shattering effect of such a shot may cause the throwing of small pieces or particles of rock a greater distance than a top blast would. Employees are, therefore, urged to heed this signal and to seek shelter with all possible dispatch.

*From the book of "Rules and Regulations" of the Nevada Consolidated Copper Company

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DIFFERENT SAND BLAST NOZZLES

BY B. H. REDDY.

Cleaning castings with sand blast apparatus can be made to show considerable economy over the ordinary method of chipping, scraping and brushing by hand, and at the same time the operation leaves the castings in such a condition that the expense of machining is reduced materially. All burned sand and scale are thoroughly removed from the surface of the castings, thus greatly lessening the wear on the edges of the cutting tools. But it is remarked frequently that although the sand blast does nice work, it is expensive. This, however, depends entirely on the manner in which the sand blasting is done. If a greater air pressure is used than is necessary to perform the work, a loss results from the excessive power required to compress the air, and there also is an unnecessary amount of sand lost through breakage of particles. Improperly designed nozzles frequently increase the expense of sand-blasting unnecessarily.

Due to the abrasive action of the medium used, the nozzle tips wear out rapidly. In an effort to overcome this, many different materials and forms of construction have been tried. Tips have been made from rubber, tempered steel and chilled iron. Nevertheless, the abrasive action of the sand cannot be avoided and although the wear has been minimized in some cases, it still exists. The rate of wear varies greatly with the type of nozzle employed.

Fig. 1 shows a section of a nozzle commonly known as the suction or injector type. The tips *A* and *B* are made of chilled iron. The air, under pressure, escapes from tip *B* through tip *A* and forms a partial vacuum in the sand hose. This sucks air and sand through the hose. The inside of tip *A* wears out rapidly while the outside of tip *B* also is cut away somewhat more slowly. When using this form of nozzle it is necessary to arrange the feed at the entrance of the sand hose in such a manner that it will not become clogged

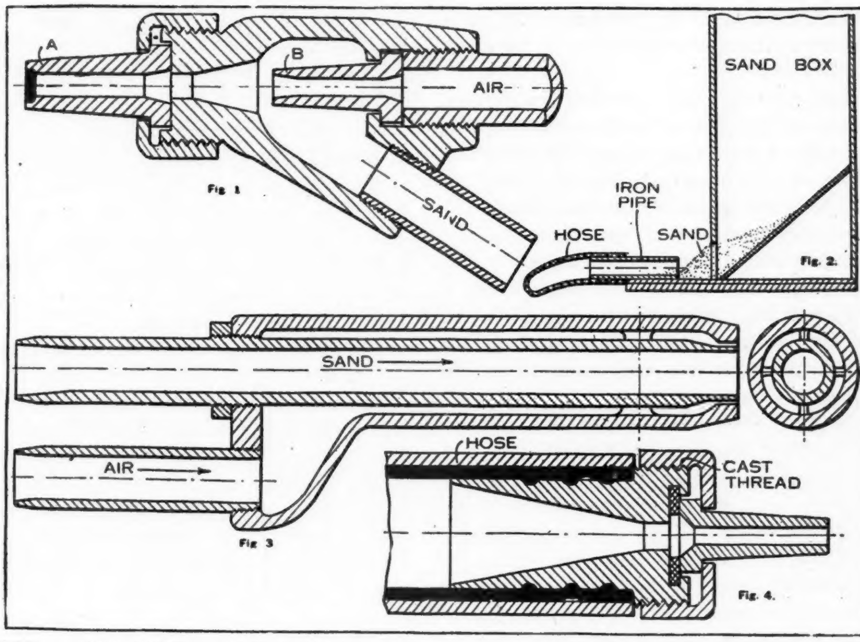

FIG. 1—INJECTOR TYPE SAND BLAST NOZZLE

FIG. 2—ARRANGEMENT OF SAND BOX AND SUCTION HOSE ENTRANCE

FIG. 3—LONG WEARING TYPE SUC TION NOZZLE

FIG. 4—CAST IRON NOZZLE FOR PRESSURE MACHINES

Fig. 2 shows a simple method by which this can be accomplished. The sand is kept in a box which is provided with a sloping floor leading to a chute through which the sand flows onto a platform. The end of the hose is fastened to the platform in such a manner that the sand is readily sucked in. The nozzle, however, is wasteful of both sand and air. By cutting off the sand supply, the nozzle may be used for removing loose sand, blacking, dust, etc., from otherwise inaccessible places in molds.

Fig. 3 illustrates a form of nozzle designed to reduce the wear at the tip. The air escapes from a narrow annular opening surrounding the end of the sand tube, and only a portion of it does useful work in carrying particles of sand. Energy is imparted to the sand only at great loss of efficiency, but the wear is reduced to such an extent that one nozzle may be used for a number of months. A nozzle of this type usually is employed in such a manner that the work lies underneath it or else it is suspended by the sand hose from an elevated bin so that the sand feeds by gravity. As there is very little suction through the sand hose, the nozzle cannot be directed upward at more than a slight angle. It is also said that it will not work in deep pockets. Nozzles of this type usually are made in such sizes that they use from 250 to 300 cubic feet of air per minute.

Fig. 4 illustrates an economical nozzle which uses about 75 feet of air per minute. In this nozzle no energy is expended in bringing up the sand; neither can any of the air escape without imparting its energy to the sand. But, on the other hand, the nozzle can be used only with a pressure type machine in which the sand is contained in a closed tank. The tip is subjected to wear, but is so designed that it may be replaced readily and the cost of maintaining the nozzle is low. The various parts can be made from castings and assembled without machine work. The tips usually are made of white iron. As the tips increase in inside diameter, the consumption of air increases. The outside of the tips may be tapered in such a manner that when the inside has been cut out to a predetermined size it will

show on the outside. Any workman can readily interpret this phenomenon as a signal to change nozzles.

Complaints frequently are heard regarding the wearing qualities of sand hose, but this is often due to the fact that proper materials are not used in manufacturing the hose. It should be borne in mind that the quality and not the thickness of the inner lining of the hose determines its resistance to wear. A lining which will stretch out almost like a good rubber band when a small piece of it is pulled out between the forefinger and thumb nail, is one which will give good service.—*The Foundry.*

CAVE AND TUNNEL FARMING

The following should appeal to our readers because we are all interested more or less in tunnels, and there are many unused tunnels which might be put to the use here suggested.

A cave in the heart of the Ozark Mountains of Missouri is the unusual spot chosen for a farm by a retired citizen of St. Louis. While looking about for a farm in the western part of his home State, Mr. Robert Smith found an attractive 26-acre stretch, beneath part of which lay a large cave. Remembering the profitable use made of caves by the mushroom growers of southern France, he determined to test the productiveness of his acquisition.

While his neighbors were digging up weeds and clearing brushwood from their lands, Farmer Smith had to uproot and haul away the stalagmites and stalactites, the lime deposits left by the incessant dripping of water during many centuries. Except for a clayey substance, ocher, which covered part of the walls, the cavern floor was bare limestone, so that the final preliminary activity was to spread soil and manure over the ground.

Mushrooms are peculiarly suitable for such a project as the cave farm. The spawn is secured in bricks, which are broken up and scattered over the floor surface. From a single mulching, and with almost no care, the farmer can harvest a new crop of marketable mushrooms every day for three months. Allowing a brief period for the fungus to attain its full size, Mr. Smith can readily plant spawn three times each year. From this promising start, the subterranean agriculturist turned naturally to rhubarb and celery. These are planted above ground, and are later transplanted in the cave. The underground ripening causes an unusually rapid growth, the rhubarb gaining on the average an inch a day in length, and also gives the stalks a superior tenderness and a rich flavor.

COMPRESSED AIR FOR STERILIZING MILK

A new process for the sterilization of milk, called the "Biorisator," is said to be in successful use in some German dairies. The milk is poured into a pressure chamber, where it is subjected by a pump to a pressure of 4 atmospheres; it is then conveyed by the same pressure to a large cylindrical vessel, which it enters in the form of a fine spray, and is, at the same time, subjected to a temperature of 167 deg. Fahr. From the cylinder it passes through a cooler, where its temperature is rapidly lowered to at least 50 degrees. From this it flows to a bottle-filling machine. The milk is subjected for only a brief time to the sterilizing temperature while in the form of a spray. The advantage claimed for the biorisator process, as a substitute for the ordinary methods of pasteurization and sterilization, is that while it insures the destruction of pathogenic germs, it produces no change whatever in the chemical composition of the milk. The latter retains all the properties of raw milk, and can be used for cheese making, besides keeping much longer than either raw or pasteurized milk.

VARYING AIR PRESSURE TO SUIT THE TIDES

Recent underground railway work in London has required the construction of a considerable length of tube under the Thames. In this part of the work, driven by the usual shield plan, the clay cover in the river bed is very thin while the tide causes considerable variation in the depth of the water over it, and on account of this it has been necessary to vary the air pressure daily during construction from 9 to 18 lb. per square inch. Had this precaution not been taken there might have been an excess of pressure at low tide, which would have lifted the river bed, whereas at high water, with too little pressure, there would be the danger of the river breaking in. The method adopted to insure that the right air pressure was maintained in the tunnel was to have a gage fixed in the river with marks corresponding to the air pressure which should be employed, and to regulate the pressure from observations of the gage readings.

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SAFETY FIRST WITH COMPRESSED AIR

Safety First, the industrial guidon of the hour, should nevermore be allowed any position but at the front of our activities, and especially should it be kept prominently in sight in compressed air practice, although nothing can well be imagined safer than air is in itself; and we should not forget that one of its chief employments is, as in the air brake and in the switch and signal service, for eliminating, or at least for minimizing, the dangers which seem inseparable from our schemes for rapid transportation.

What air has done for safety in this field alone is incomputable. It is a curious thing that while casualties are self recording, while complete lists of accidents which have occurred are generally accessible, there are no records and no possibility of recording the accidents which might have occurred, which surely would have occurred, only that they have been prevented by the operation of safety devices, and especially by those pneumatically operated, so that compressed air does not receive the honors it earns.

And yet compressed air has its conditions—if it is permitted to it to have them—which are not all in the line of perfect safety; but the arrangements to be adopted for avoiding the possible dangers are all in the direction of practical economy as well, so that, independently of the value of the safety secured, it is cheaper to produce compressed air—the compressed air produced is cheaper—which is also produced under safe conditions.

One of the first conditions essential to safety in the use of compressed air is that the air after compression shall be as pure as possible. This applies especially to caisson work where all the air breathed by the workers is what comes from the compressor, and if this air is charged with vapor or smoke from highly heated or burnt oil it is very different for respiration from air which is not so vitiated.

The danger to which the sand hog is exposed in his work has too generally been thought of as that due to the pressure alone, but the purity of the air in which he works has also much to do with it, and it would seem to be high time that this was more generally recognized. Of course the less oil there is used in air cylinder lubrication the less of the oily constituents there will be in the air as it is delivered to the work. This applies as well

to tunnel headings or wherever the air which has been compressed is afterwards breathed by the men. We have published in these pages accounts of the minute quantities of lubricating oil used in the compressors on the Panama Canal, and still less elsewhere. The reduction in the quantity of oil used, and in the cost of it, may not be a very large item in the total running expenses, but it is still in the direction of economy of operation.

The matter of keeping the air as cool as possible during the compression and delivering it as cool as possible and as dry as possible after the compression is still more important as a means of safety, and of comfort, and it also is an essential condition of economical operation. We know that two stage compression, at least for all pressures above 50 lb., is necessary if the temperature is to be kept down, and we know also that power is saved by this arrangement. The intercooler, the aftercooler and the separator cost nothing except for their installation, while the resulting economy and collateral benefits are indisputable.

By the way, the matter of moisture in the air is treated in easily readable style in another article in our present issue.

LOW PRESSURE ILLUMINATING GAS

"In Syracuse, N. Y., a city with 170 miles of gas mains of from 2 to 20 in. diameter, the pressures varies from $1\frac{1}{2}$ to $3\frac{1}{2}$ in. of water, or, say $\frac{1}{20}$ to $\frac{1}{8}$ lb. per sq. in."

Some reader of Frank Richards' new book, *Compressed Air Practice*, has started the above interesting item on its rounds; we clip it from the *American Machinist*. The fact is that Syracuse was merely cited as typical of all the cities in the country, where distributing pressures adopted more than a century ago are still submitted to. If customers need higher pressures to enable them to use the gas more economically and satisfactorily they must make arrangements of their own for increasing the pressure, and not disturb the gas holders or the costly but incompetent pipe lines.

The recorded sales of gas for the boroughs of Manhattan and the Bronx, New York City, for the year 1913 were 26,262,457,670 cubic feet, an increase of only 0.39 per cent. over 1912.

AN IMPORTANT COMPRESSOR CONTRACT

The Isthmian Canal Commission has just awarded to the Ingersoll-Rand Co., the contract to furnish three large Direct Connected, Electrically Driven Air Compressors of the Duplex Type, embodying the new Ingersoll-Rogler valve. The combined capacity of these units will be 10,000 cu. ft. free air per min. They will be installed at the Balboa shops, where the air will be used for general repair work in the shops and also on the new dry dock. This equipment is to form a part of the permanent canal equipment.

HIGH PRESSURE GAS AT THE SAN FRANCISCO EXPOSITION

It seems to be coming more and more to be understood that when gas is to do its best it must be used at pressures much higher than these vouchsafed to ordinary, every day consumers. The following abstract from *The Gas Record* is suggestive in this direction.

"At the Panama-Pacific International exposition it is believed that some of the most spectacular lighting effects will be gained where the gas system is employed. This will be particularly noticeable in the Court of Abundance designed by Louis C. Mullgardt. The court will be illuminated almost entirely by gas under high pressure. Urns will be placed about the court and on the border of a still lagoon in the center, from which twisted gas flames ten to fifteen feet in height will rise.

"Steam jets constantly will be pouring a cloudy vapor over the entire court and casting a haze over the reddish-yellow flames. By an ingenious scheme free gas will be forced through the water in the lagoon and ignited upon reaching the surface. These giant bubbles of inflammable gas will burst at intervals of a few seconds. The effect of these seemingly mysteriously derived flames augmented by steam under pressure may be readily imagined.

"The essential secondary system of lighting for the exposition will be by means of gas arcs installed in all of the exhibit palaces and in entrances and about the grounds. The street lighting in the states and foreign sections and in the concessions district will be exclusively by means of gas.

"It will be distributed through a high-pressure system by a San Francisco company

and will be the oil gas which is used in California and is made from crude petroleum. Its heat value is 600 B. t. u. per cubic foot and even more and it has a candle power in excess of 18. The pressure on the grounds will be thirty pounds.

"While the gas will be distributed at thirty pounds pressure it may be reduced to any amount suited to the use to which it will be put by means of regulators which will be installed upon request, by the company supplying the gas."

The big gas holder will of course be conspicuous; but it will be conspicuous by its absence.

SPRAYING MOLTEN METALS

In COMPRESSED AIR MAGAZINE, September, 1911, a description was given of the Schroop metal coating process. By this process articles composed of almost any solid material, and even textiles, are coated by directing upon them a fine spray of molten metal which solidifies as it is deposited. An improved apparatus in the same line has recently come into use and is described in the *Revue de Metallurgic,* Paris, Dec., 1913.

The machine is called a pistol syringe. The metal in the form of wire is fed automatically into it, and melted by means of an oxy-hydrogen flame, or a flame where the hydrogen is replaced with illuminating gas. The molten metal is sprayed with compressed air which also works a small turbine that advances the wire. The use of metallic powder is therefore obviated. The details of the construction are given, and several views of it in use. The most diverse metals can be used—lead, tin, zinc, aluminum, copper, brass, etc. The inventor also anticipates a successful use of glass and enamel. Very thin coatings can be produced for purely decorative purposes, or thicker ones that can be polished by ordinary methods, and if desired removable coatings several millimeters thick for reproducing medals, plates for engraving, etc.

THE MOST SERIOUS DANGER IN COAL MINING

Falls of roof and falls of coal were during the year of 1912 responsible for the loss of a larger number of lives and a larger number of serious permanent injuries than can be attributed to any other two or three causes. The causes of these accidents are much more complex than is usually supposed, and to apply the remedial measures adopted in some other countries would greatly increase the cost of coal to the American consumer. The subject is, therefore, worthy of a careful investigation, which it is estimated, would cost $35,000 to $40,000 a year for several years. This cost is insignificant when it is remembered that from this cause alone during the past five years more than 5,000 lives have been lost and many times that number of other serious accidents have occurred. Taking the average recent compensation rate of $3,000, the labor loss to the country from this one cause has been more than $15,000,000 in five years, and the loss is much greater if the associated permanent nonfatal injuries be considered.

In those districts where the prevailing practice has been to shoot off the solid, the growth of a sentiment in favor of undercutting the coal is noticeable. Shooting off the solid—with the attendant use of large charges of explosive which shatter the coal, increase the proportion of fine dust, and injure the roof—has been responsible for more accidents to miners and more loss of property than almost any other coal-mining practice.—*Annual Report Bureau of Mines.*

PYRENE AS A FIRE EXTINGUISHER

Pyrene is a combination of powerful gases maintained in liquid form without pressure and absolutely devoid of moisture. When pyrene liquid is subjected to a temperature of 200 degrees F. or over, it is immediately transformed into a heavy, dry, cohering, non-poisonous, gas blanket. When the contents of a pyrene extinguisher are thrown on a fire 3,760 cubic feet of extinguishing gas is generated. The hotter the fire, the greater is the expansion of gas. In its liquid state pyrene contains neither acid nor alkali, and it does not deteriorate with age.

A scenic road is being built from Revelstoke, B. C., up Mount Revelstoke to Victoria Park on its summit. Commencing on the western boundary of the city, at an altitude of 1,450 feet, with the aid of five switchbacks, the road reaches the summit, 12.8 miles distant, at an altitude of 6,150 feet.

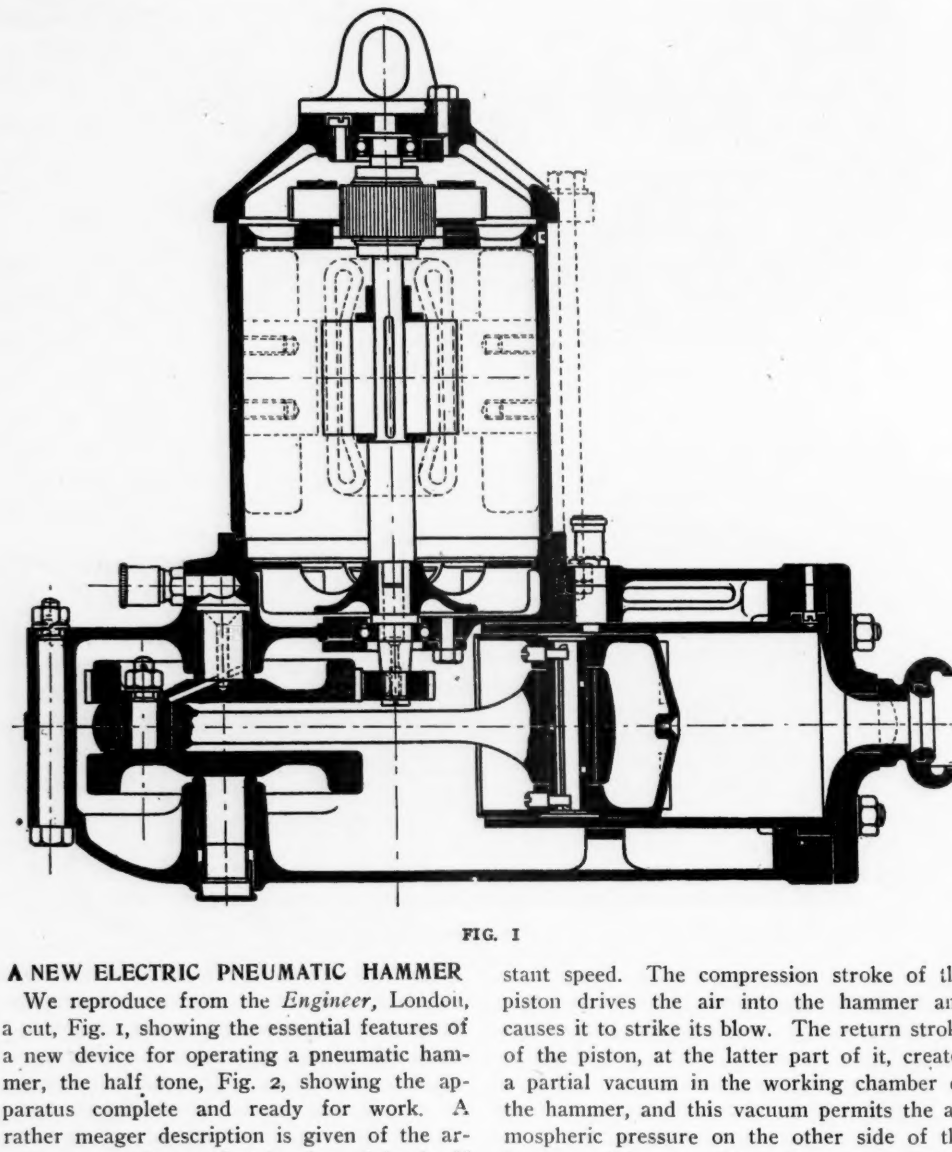

FIG. I

A NEW ELECTRIC PNEUMATIC HAMMER

We reproduce from the *Engineer*, London, a cut, Fig. 1, showing the essential features of a new device for operating a pneumatic hammer, the half tone, Fig. 2, showing the apparatus complete and ready for work. A rather meager description is given of the arrangement and operation, but it explains itself quite clearly. There is an electric motor connected by speed reducing gearing to a shaft the crank of which drives the piston of a single acting air compressor or pulsator. A small air hose connects the pulsator with the hammer to be operated, permitting the latter to be moved about with perfect freedom within the reach of the hose.

The motor, crankshaft and pulsator piston may be assumed to run at approximately constant speed. The compression stroke of the piston drives the air into the hammer and causes it to strike its blow. The return stroke of the piston, at the latter part of it, creates a partial vacuum in the working chamber of the hammer, and this vacuum permits the atmospheric pressure on the other side of the hammer piston to return it to the starting position for the next working stroke, and so on.

It is to be remembered that in the various types of pneumatic hammer in use, and also in the electric air drill, positive air pressure is employed for the return stroke of the piston, and it is not to be believed that the partial vacuum used for the return stroke in the apparatus here illustrated can ever be sufficient for rapid and effective working.

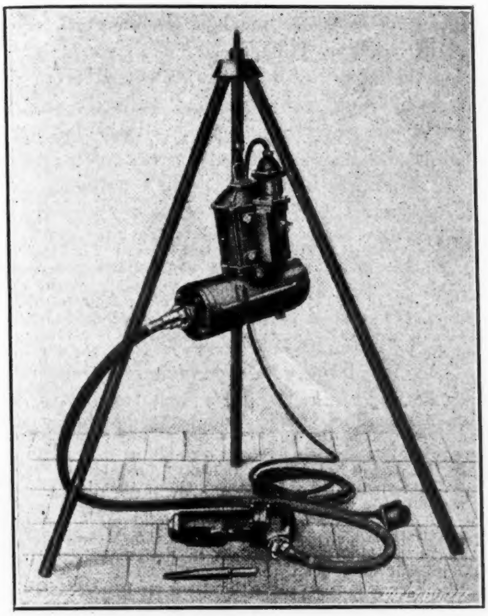

FIG. 2.

A STETHOSCOPE TRICK

Down in Williaim street there is a large building devoted mainly to the insurance business. It is in every way a successful building. The biggest leak in overhead charges in this building was in the water bill, says *The Real Estate Record and Guide.*

The owner watched for wastefulness, but could not find it. Finally, one Sunday, he borrowed the stethoscope, of his brother-in-law, who is a physician, and, with the aid of his engineer and superintendent, went over the piping, shutting off the water supply at each cut-out station. After going over all of the open plumbing work that was exposed they passed to the roof tank and there made an important discovery.

One of the plate rivets had unaccountably disappeared and permitted a stream of water about three-quarters of an inch in diameter to escape. This water, raised to a distributing point by an expensive pump battery, discovered an outlet by following one of the steel columns down to the roof, where it found its way between the roof tiles and the ceiling to a point in a side wall, where it forced its way out under a window sill abutting the neighboring building, and thence flowed down fourteen stories to the ground, without revealing its presence through the roof or ceiling at any point.

Without the aid of the stethoscope, which directed the searchers to the hidden leak, the fault would probably not have been discovered until some important part of the steel framing had been weakened by rust or seepage and endangered the foundation.

NOTES

Mr. George A. Gallinger, of Pittsburgh, has been placed in charge of the Pneumatic Tool Department of the Ingersoll-Rand Company with the title of Manager of Pneumatic Tool Sales. His headquarters will be at 11 Broadway, New York City.

In the last three years the excavation incident to the mining of coal in West Virginia alone has been greater than the excavation required in eleven years to dig the Panama Canal.

A 250-mile pipe line is being built for H. M. Byllesby & Co., of Chicago, from the West Virginia gas fields to Louisville, Ky. Some 76 miles of difficult construction through the mountains has already been completed.

Mr. Frank B. Gilbreth, the well known "efficiency engineer" has started a museum at Providence, R. I., for the exhibition of devices for eliminating fatigue. The fatigue of readers of scientific management "literature" should be relieved in some way. Everybody in these days seems to need a rest.

The composition of natural gas as used at Pittsburgh is: 83.1 per cent. methane or marsh gas, 16.0 per cent. ethane, 0.9 per cent. nitrogen, with a trace of carbon dioxide. The most explosive mixture of this gas with air has the proportion 8.6 : 91.4.

Carpet manufacturers in Europe, who formerly had to send samples of their product to southern countries to test their sun-resisting qualities, now use the mercury-vapor quartz lamp for that purpose, its ultraviolet rays having even greater power to fade dye-stuffs than the sun.

In advertising for proposals for a pressure tunnel for sewage beneath a portion of New

York Bay and Jersey City, it was provided that if water was encountered in such quantity as to render free air methods impracticable, the contractor should have the right to abandon his contract without incurring any penalty.

One of the stations on the newly opened railway from Bandolier Kop to Messina, in the Northern Transvaal, which traverses a region in which great heat is frequently experienced, has been given the name "Ottazel." It is very evident that the name originated with an Englishman.

It is stated that the pumping station for the Jefferson and Plaquemines Drainage District in Louisiana will be the largest in the world, having an ultimate capacity of 900,000,000 gallons in twenty-four hours. There will be installed four 76-in. pumps of 192,000,000 gallons capacity each and two 48-in. pumps of 64,000,000 gallons each per day.

At the Chapin mine, Iron Mountain, Mich., a diamond drill hole was started at 45 degrees and pointing south. It struck ore at 725 feet, corresponding to the eighth level of the mine, if it had continued in the direction in which it was started. Later it was found by the mine workings on the seventh level 96 feet higher and 70 feet south of its supposed position, due to the flattening of the hole.

It is reported from Kearsarge, Mich., that after exhaustive tests the Wolverine Copper Mining Co. has standardized its drill equipment. There are now in use and on order 50 No. 18 Leyner-Ingersoll drills and 16 Jackhamers. This is sufficient for the complete equipment of the property; and operating records at the Wolverine will be watched with considerable interest by other mine superintendents in the copper country, where there is a marked tendency towards standardization

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Budapest is the first city in the world to set up slot-machine savings banks. The machines are arranged for the receipt of two coins, the crown, worth about 20c., and the 20-filler piece, worth about 4c. They return a ticket for each coin deposited, and these tickets bear interest from the date of their issuance. The rate paid varies with the current bank rate and ranges from 3 to 4 per cent.; 110 tickets may be exchanged for a bank book.

A wind motor claimed to be the largest of its kind in the world has lately been brought into use at Harlingen (Friesland) for a polder (tract of lowland redeemed from the sea by high embankments) with an area of 1850 acres. This machine, which has steel sails and is mounted on a steel tower, has a diameter of 50 ft. and is said to be capable of dealing with 64,000 to 70,000 cu. ft. of water per hour. Wooden windmills first used for this work were largely superseded by explosion motors, and now the steel "wind motors" are more and more employed.

At St. Johns, Newfoundland, the government has granted a concession for the use of one million h. p. water power at the Grand Falls, Labrador, with which it is intended to generate electricity for the extraction of nitrogen from the atmosphere. Proposals have been made to start a lime-nitrogen fertilizing industry in the Himalaya Mountains, and particularly in Kashmir, where water power is already developed, and lime deposits are abundant. The company is still expanding, and it is expected that the output of nitrate of lime in 1915 will reach 160,000 tons. The Société has also granted licenses for Spain, and works of 25,000 h. p. are being constructed at Lerida.

Telephone apparatus which operates satisfactorily in the United States sometimes develops trouble in the more humid climate of the tropics. The exchanges in the canal zones use electric heaters in the terminal rooms, and lamps in the switchboards, in an effort to keep the apparatus as dry as possible.

Emil Gathmann, of Baltimore, Md., has provided a nozzle for pneumatically operating cotton pickers. It flares outwardly with a funnel shape, and has on its inner side a spiral-toothed rib with a plurality of connected convolutions designed to engage the cotton, dislodge it from the boll and direct it inwardly into the machine.

The evaporative efficiency of oil, if thoroughly atomized in a well designed burner, is considerably higher weight for weight than that of coal. Results of trials show that 1 lb. of crude petroleum with a net calorific value of from 18,000 to 18,250 B.t.u. will evaporate from 14½ to 15 lb. of water from and at [illegible] deg. F

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 3

1,088,689. REPEATING AIR-RIFLE. ARVID ECK, St. Louis, Mo.

1,088,854. FUEL-FEED SYSTEM FOR ENGINES WITH STARTERS. GEORGE R. WADSWORTH, Cleveland, Ohio.

1. In combination with an internal combustion engine, a fuel supply tank from which fuel is adapted to be forced to the engine by air pressure, an air pump for creating pressure in the tank, and a starter for starting the engine and for actuating the pump.

1,088,860. COMBINED ELASTIC AND PNEUMATIC TIRE. FREDERICK H. WILBUR, Lestershire, N. Y.

1,088,884. PNEUMATO-ELECTRIC TRACKER-BAR FOR MUSICAL INSTRUMENTS. CHARLES W. DORRICOTT, Philadelphia, Pa.

1,088,935. TRACK-SANDER. WALTER B. ROGERS, Knoxville, Tenn.

1,088,984. ROCK-DRILLING MACHINE. CHARLES C. HANSEN, Easton, Pa.

1,089,033. OIL-BURNER. JOHN ROBERT ARTHUR, Roanoke, Va.

1,089,038. PERCUSSIVE TOOL. LEWIS C. BAYLES, Easton, Pa.

1,089,050. INFLAMMABLE-GAS INDICATOR. ANDRE GUASCO, Paris, France.

1,089,062. BLAST-DISTRIBUTER FOR WINNOWING-MACHINES. FRANK F. LANDIS, Waynesboro, Pa.

1,089,101. FLUID-METER. HARLEY C. ALGER, Chicago Heights, Ill.

1,089,106. CAR-STEP-OPERATING SYSTEM. FRED D. BLAKE, Charlotte, N. C.

1. The combination with foldable car steps, means for holding the steps in extended position, and means for automatically folding the steps when released, of means operated by *air under pressure* for actuating the holding means to release the steps, and means operated by the application of motive power to the car, for controlling the application of air under pressure to said releasing means.

1,089,108. SYSTEM FOR OZONING LIQUIDS. GEORGE F. BUTLER, Niagara Falls, N. Y.

1,089,243. FLUID-ACTUATED TOOL. MAX MAXIMILIAN, St. Louis, Mo.

1,089,326. PRESSURE-GAGE. MARVIN LOGAN CHILSON, Webster, S. D.

1,089,358. PNEUMATIC PLAYING ATTACHMENT FOR MUSICAL INSTRUMENTS. ROBERT J. BENNETT, Moline, Ill.

MARCH 10

1,089,388. STEEL-GRIT BLAST-MACHINE. ROBERT J. BARR, Erie, Pa.

1,089,391. BOAT-PROPELLER. JOSEPH S. BLATZER and PHILIP J. PAWLOSKI, Pontiac, Mich.

1. The combination with a boat, having a plurality of propeller boxes along each side, of a main propeller and shaft, a plurality of side propellers vertically disposed and ordinarily resting in said boxes, a plurality of cylinders and pistons, one cylinder and piston connected with each side propeller, a means for furnishing compressed fluid to the pistons for forcing the propellers outward, and driving connections on the said propellers and the main propeller shaft for interengaging when the said propellers are forced out by the said pistons and cylinders, substantially as described.

1,089,397. RELIEF DEVICE FOR COMPRESSORS. RUDOLPH CONRADER, Erie Pa.

1,089,414. AUTOMATIC TROLLEY-POLE CONTROLLER. MARK B. JOLLIFFE, New Haven, Conn.

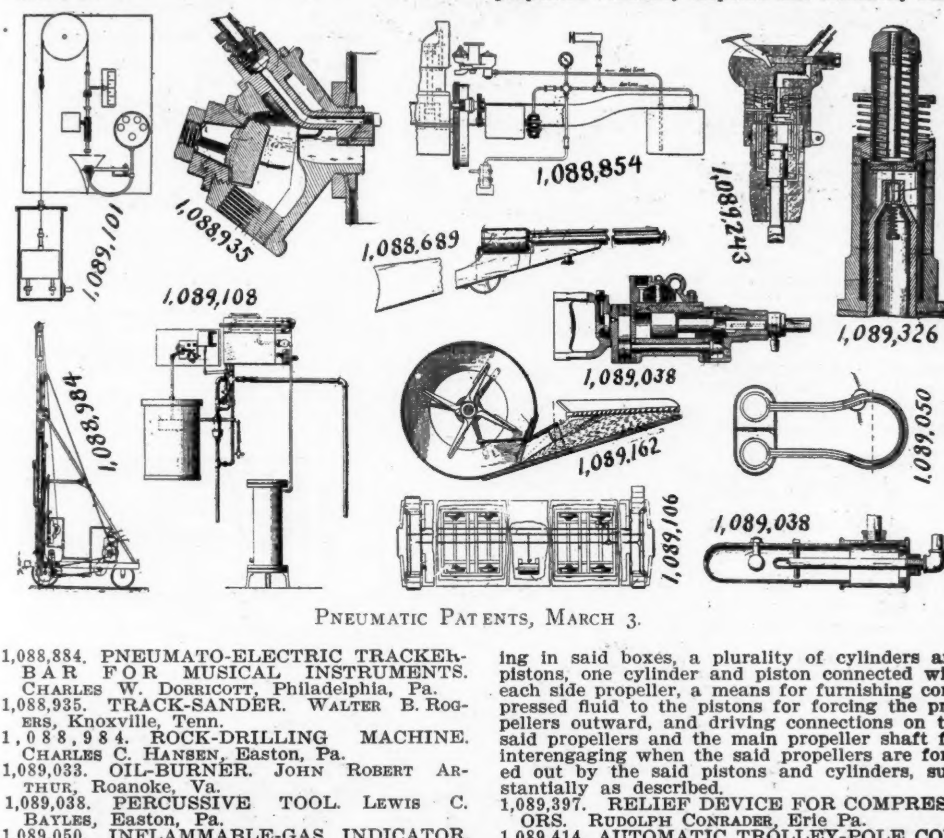
1,089,436. VALVE FOR PERCUSSIVE TOOLS. CAID H. PECK, Athens, Pa.

1,089,517. FLUID-PRESSURE DEVICE. GEORGE WESTINGHOUSE, Pittsburgh, Pa.

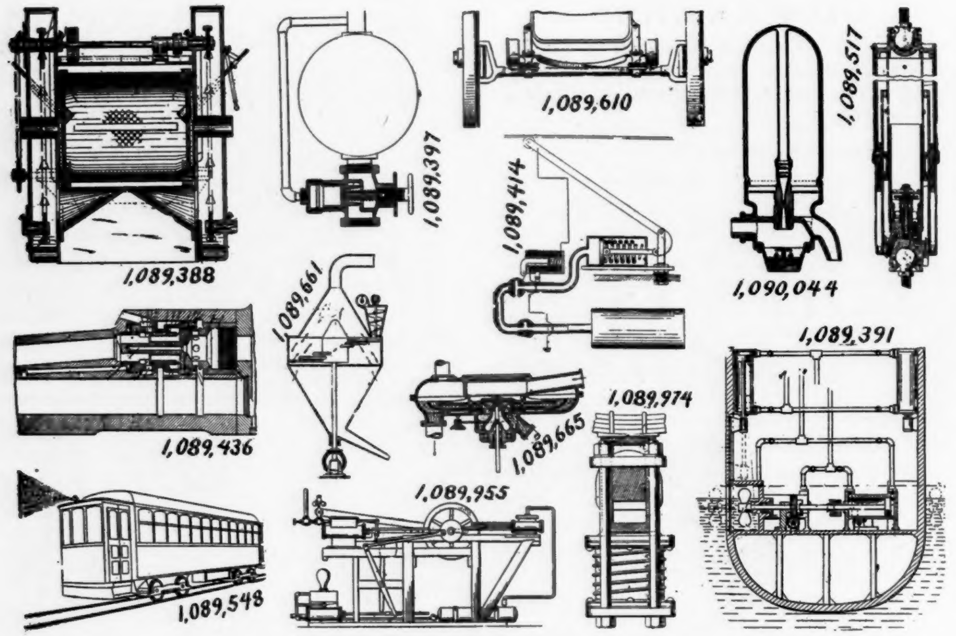
1,089,548. AIR-PURIFIER. EDWARD L. GROSS, Chicago, Ill.

1,089,610. PNEUMATIC SUSPENSION DEVICE FOR VEHICLES. JOHN WILLIAMSON, Brooklyn, N. Y.

1,089,652. PNEUMATIC BED-SPRING. JOHN J. LISBAE, Canton, Ohio.



PNEUMATIC PATENTS, MARCH 3.



PNEUMATIC PAT ENTS, MARCH 10.

1,089,661. APPARATUS FOR SEPARATING FIBERS FROM OTHER MATERIALS. PAUL HERMANN MINCK, Bremen, Germany, and EDWARD CARSTENSEN DE SEGUNDO, London, England.

1,089,665. CENTRIFUGAL AIR-PUMP. GUSTAV PAGEL, Charlottenburg, Germany.

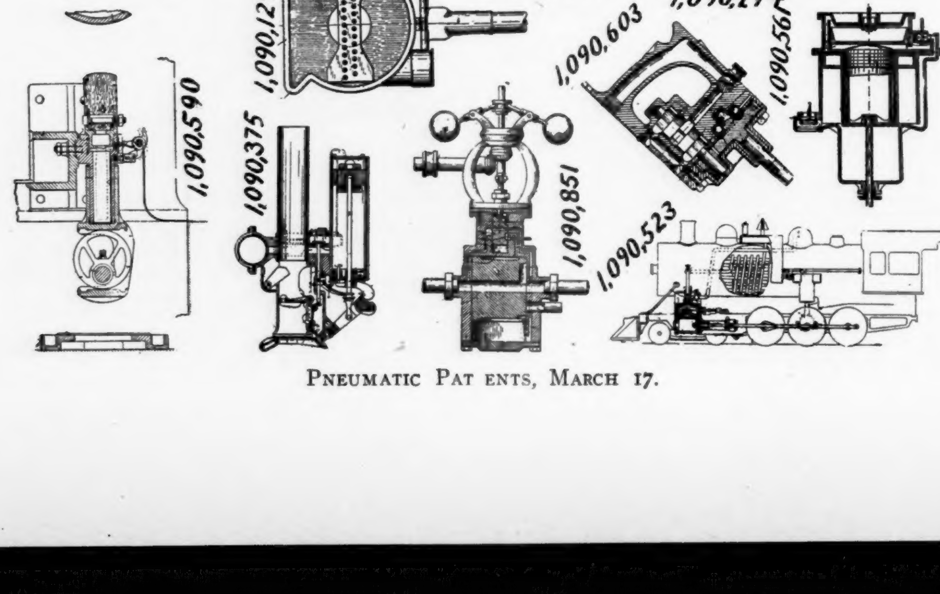
1,089,765. PNEUMATIC PLAYER - ACTION. EMORY C. HISCOCK, Chicago, Ill.

1,089,800. PNEUMATIC SWEEPER. JOHN G. STAMM, Canton, Ohio.

1,089,955. PUMPING APPARATUS. SAMUEL J. PETERSON, Valdosta, Ga.

1,089,974. PNEUMATIC SUPPORT AND SHOCK-ABSORBER FOR VEHICLES. S. WALTER SCOTT, Troy, N. Y.

1,090,044. SYSTEM FOR TREATING LIQUIDS WITH OZONE. MAX FUSS, Frankfort-on-the Main, Germany.



PNEUMATIC PAT ENTS, MARCH 17.

MARCH 17

1,090,127. VACUUM CLEANING APPARATUS. JAMES THOMAS ATWOOD, Rockford, Ill.

1,090,129. SUCTION-CLEANER. EDWARD M. BARNES, Hastings, Mich.

1,090,274. SAFETY AIR-BRAKE APPLIANCE. ALFRED A. CARPENTER, Sherman, Tex.

1,090,375. PNEUMATIC-DESPATCH APPARATUS. THOMAS BEMIS, Indianapolis, Ind.

1,090,523. COMBINED STEAM AND COMPRESSED-AIR ENGINE. HIRAM G. FARR, Melrose, Mass.

1. The combination with a steam-driven locomotive having a steam chest and a cylinder supplied thereby, of means mounted on and actuated by movements of the locomotive for storing air under compression, and connections between the stored air and the steam chest for admitting air to the chest at will independently of the steam supply, whereby the cylinder supply may be composed of either steam or air or a combination of both, said connections extending into the steam space of the locomotive whereby the air supplied to the chest will be heated.

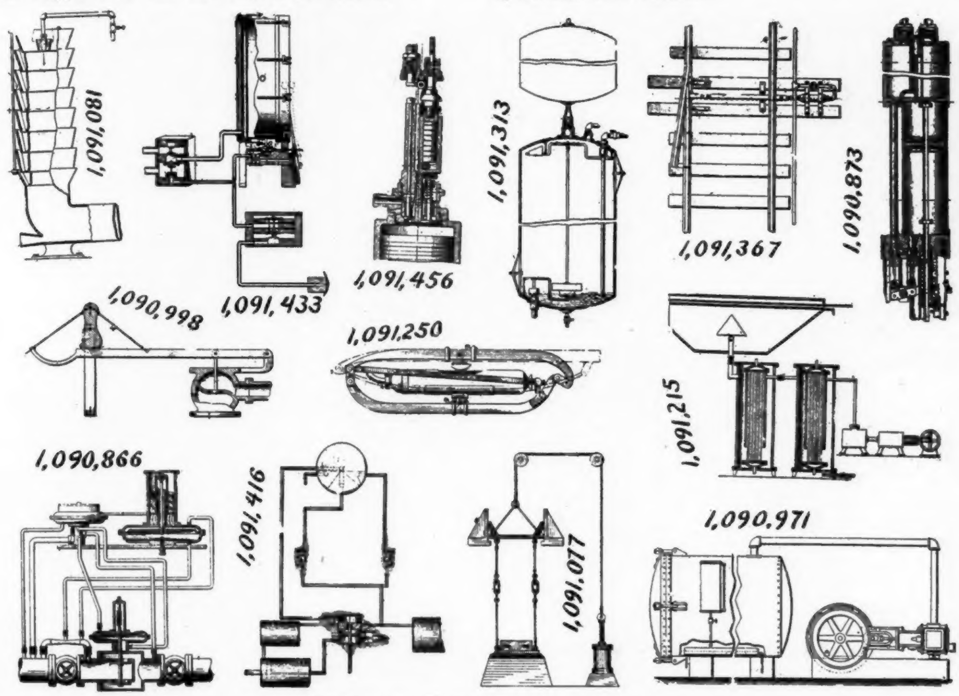
1,090,790. VALVE MECHANISM FOR PNEUMATIC TOOLS. GEORGE A. OLIVER, Denver, Colo.

1,090,806. AUTOMATIC AIR-BRAKE CONTROL FOR RAILWAYS. HARRY J. WARTHEN, Washington, D. C.

1. An air-brake control device for railway trains, in combination with a fluid-pressure supply and train-pipe, of a piston-valve through which the fluid-pressure passes to the train-pipe, a control-valve for admitting fluid-pressure to the piston-valve, a solenoid having a weighted staff for closing the control-valve, and an electric circuit for the solenoid to open said control valve.

1,090,807. DEVICE FOR CONTROLLING THE SPEED OF RAILROAD-TRAINS. HARRY J. WARTHEN, Washington, D. C.

1. A speed control mechanism for use in connection with an air-brake system, comprising a piston-valve through which the air pressure passes for application of the air-brakes, means for admitting pressure to opposite sides of said piston-valve, respectively, and a governor for operating said means.



PNEUMATIC PATENTS, MARCH 24.

1,090,561. COMBINED EXPLOSION OR INTERNAL-COMBUSTION AND COMPRESSED-AIR ENGINE. PAUL NOLET, Brussels, Belgium.

1,090,590. BEETLING-MACHINE. THOMAS OWEN ARNFIELD and WILLIAM BOOTH, New Mills, England.

1. In a pneumatic beetling machine a lower movable cylinder, a fixed cylinder, a sliding hammer support inside said fixed cylinder, a hammer on said support to act against a beam the movable cylinder charging the fixed cylinder during its downward stroke and actuating the sliding hammer support on its return stroke to drive the hammer upward to the beam, the sliding hammer support falling by gravity assisted by air suction as set forth.

1,090,603. PORTABLE PNEUMATIC TOOL. ETHAN I. DODDS, Central Valley, N. Y.

MARCH 24

1,090,841. ELECTROPNEUMATIC BRAKE SYSTEM. JAMES S. DOYLE, New York, N. Y.

1,090,866. PRESSURE-INCREASER. ERNEST F. LLOYD, Detroit, Mich.

1,090,873. PNEUMATIC PUMP. OTTO R. PFAU, Milwaukee, Wis.

1,090,893. VACUUM-GOVERNOR. FRANK W. VAN NESS, Milwaukee, Wis.

1,090,907. PNEUMATIC-DESPATCH-TUBE SYSTEM. FERNAND E. D'HUMY, Englewood, N. J.

1,090,971. METHOD OF AND APPARATUS FOR MOISTENING YARNS. OSBORN H. CILLEY, Westford, Mass.

1. A method of moistening yarn which consists in placing the yarn in a receptacle having a surface evaporator entirely inclosed therein,

placing a predetermined quantity of water on said evaporator within said receptacle, reducing the air pressure in said receptacle and evaporating the water by heating said evaporator by steam circulating within the evaporator but out of contact with the water therein.

1,090,998. APPARATUS FOR PREVENTING RAILWAY ACCIDENTS. HAVARD L. LOCKART, Philadelphia, Pa.

1. The combination with a railway vehicle having an air brake and a valve casing connected with the air brake, a valve in said casing, a stem on the valve projecting through the casing, a pivoted arm connected to the stem and normally holding the valve in closed position, a cam lever engaging the arm, breakable means holding the lever, and a tripping arm operated in unison with a signal and adapted when the signal is at danger to strike the cam lever and cause the latter to move and permit the valve to open, substantially as described.

1,091,077. JOLT-RAMMING MECHANISM. EDGAR H. MUMFORD, Plainfield, N. J.

1,091,081. STEAM OR AIR BLOWER. EDWARD RENARD, Lewistown, Pa.

1,091,416. AIR-BRAKE. ANDREW J. WISNER, Philadelphia, Pa.

1,091,433. SNARE-DRUM DAMPER. ROBERT HOPE JONES, North Tonawanda, N. Y.

1,091,447. PNEUMATIC TOOL. LAWRENCE LEE WAGNER, Lakemont, Pa.

1,091,456. AIR-PUMP. CARL E. L. LIPMAN, Beloit, Wis.

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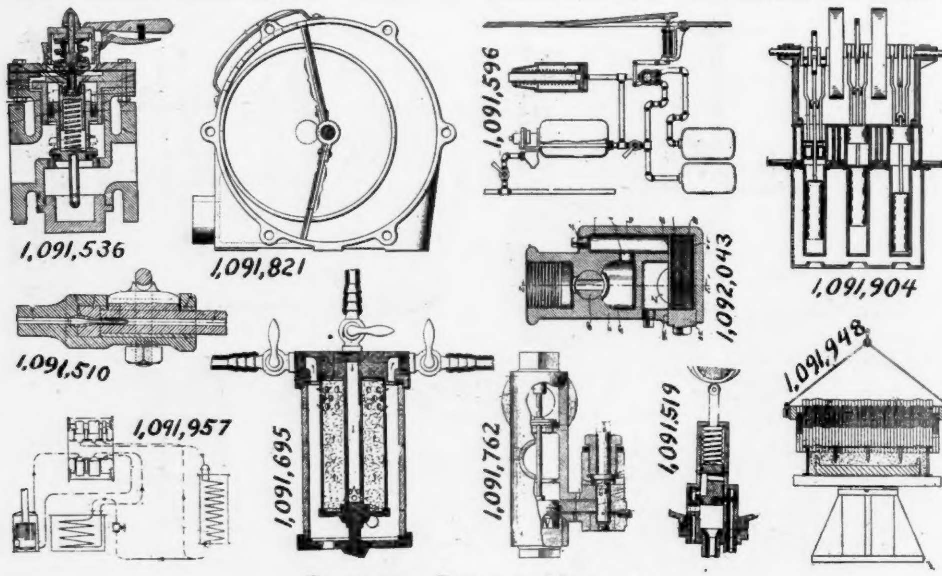
1,091,510. CHUCK FOR ROCK-DRILLS. CHARLES C. HANSEN, Easton, Pa.

1,091,519. ENGINE-STARTER. CHARLES M. LEECH, Lima, Ohio.

1. The combination with an internal combustion engine comprising a cylinder, a piston operating therein, a closed crank case, a crank shaft, and a pitman connecting the piston and crank shaft, of means to supply compressed air into the crank case to move said piston in one direction, and means automatically operated by the movement of the piston to cut off the supply of compressed air from the crank case and establish communication between the interior of the same and the atmosphere, so that the piston may move in a reverse direction.



PNEUMATIC PATENTS, MARCH 31.

1,091,112. FLUID-PRESSURE-OPERATED HAND-TOOL. LEWIS C. BAYLES, Easton, Pa.

1,091,215. APPARATUS FOR DRYING BY COMPRESSED AIR. WILLIS E. HALL, New York, N. Y.

1. An apparatus for drying by compressed gaseous fluids, comprising a fluid compressor, a moisture separator for eliminating moisture from said fluid, a chamber for collecting such fluid after said elimination has taken place, a means for bringing the fluid to a predetermined temperature and a controlling device arranged to permit the ejection of said compressed dried fluid at a predetermined pressure, said compressor, moisture separator, chamber, means and controlling device being in communication with each other.

1,091,250. PNEUMATIC SUSPENSION FOR VEHICLES. WILLIAM SELLENGER, Richmond, Victoria, Australia.

1,091,313. AIR-COMPRESSOR. CARL H. ERICKSON, Denver, Colo.

1,091,367. PNEUMATIC DERAILER. JOHN J. MCINTYRE, Uniontown, Pa.

1,091,383. VACUUM-CLEANER. ULYSSES C. OBLOSSER, Bloomsburg, Pa.

1,091,529. PUMP AND AIR-COMPRESSOR. LEWIS HALLOCK NASH, New York, N. Y.

1,091,536. PRESSURE-REGULATING VALVE. WILLIAM ROSS, Troy, N. Y.

1,091,596. LOAD-CONTROLLED AIR-BRAKE. JACOB RUSH, SNYDER, Pittsburgh, Pa.

1,091,695. AIR-FILTER. PAUL E. NOLDEN, St. Louis, Mo.

1,091,762. HIGH-PRESSURE RELEASE-VALVE. FRANK PHELPS, Little Rock, Ark.

1,091,821. ROTARY PNEUMATIC PUMP. FREDERICK C. FESENBEK, Philadelphia, Pa.

1,091,904. HOT-AIR MOTOR. ERNEST A. WULLENWEBER, Detroit, Mich

1,091,948. SAND MOLDING APPARATUS. EDGAR H. MUMFORD, Plainfield, N. J.

1,091,957. APPARATUS FOR REFRIGERATING BY MEANS OF LIQUEFIED GAS. FREDERIC AUGUSTIN POLLARD, Parc St. Maur, France.

1,092,043. CROSSOVER CONNECTION FOR FLUID-BRAKE SYSTEMS. WALTER F. HAMMOND, Rocky Mount, N. C.